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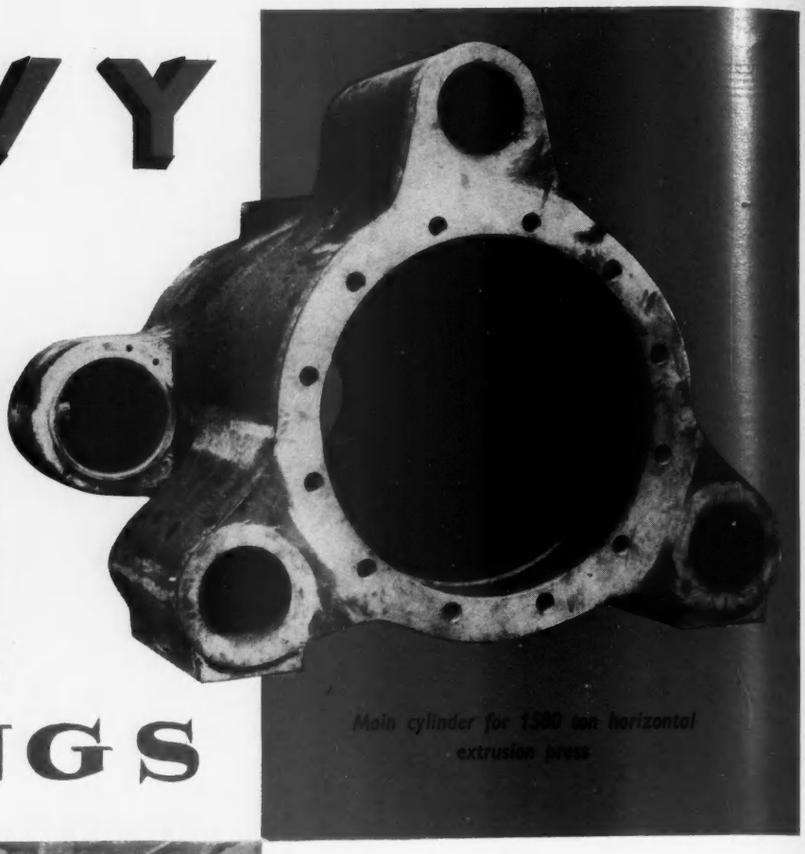

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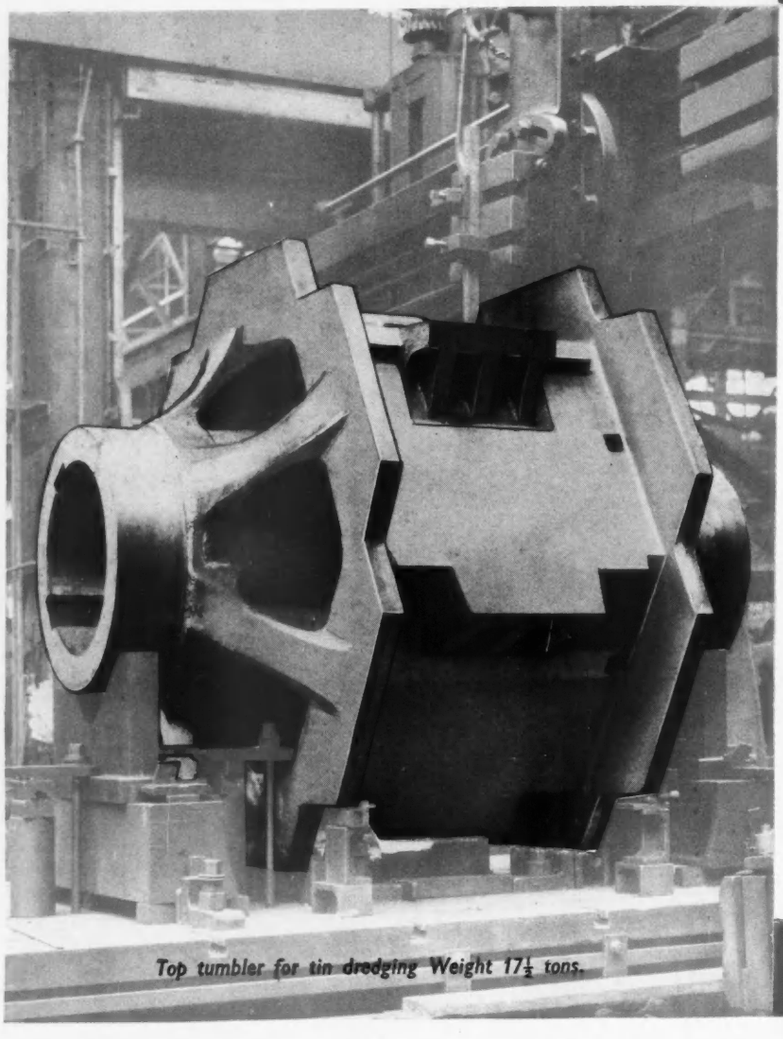

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ENGINEERING

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As Taught in the 21st Century

LIKE the guidance system of a rocket, education must look in two directions at the same time: forward to keep an eye on a shifting target, and backward for corrections to its bearing. With the aim of reconciling these two requirements, the Science Masters' Association will shortly be presenting their new syllabus for the teaching of science in secondary schools.

From the past, education transmits the accepted values of the parent society to the new generation; in this sense education is a society's instrument of self preservation. In a conservative society this may be the chief or the only function of its educational system, but in a progressive society education must cater to the needs of the future and to that extent it must be utilitarian. The needs of the future can only be predicted from experiences in the past, and our best estimates will suffer from the disadvantages of extrapolation. The further we extrapolate, the less likely we are to be accurate in our predictions. It is not always realised how far forward one has to look.

If it is decided today that an important change is required in the syllabus of secondary schools, it is first necessary to incorporate the change into the syllabus of universities and teacher training institutions. It will be 1970 before new books are written and printed and the effects of the change filter down to the level of secondary schools; and another ten years pass before the first generation of students matures. Four or five more years are spent at university, and another ten to fifteen years before members of the new generation exert their influence, before they produce an effective "feed-back" of the ideas that originated 30 or 40 years before. A syllabus planned today will come into full effect only in the 21st century.

There is nothing magical about numbers; the first year of the 21st century will not differ much more from the last years of the 20th, than 1960 will differ from 1959. But the change from 1960 to 2000, the imponderable gap in our extrapolation, will be greater, much greater than the change over any previous span of 40 years. The syllabus of secondary schools must attempt to anticipate the needs of a very different society from ours, a society belonging to the 21st century. The syllabus must reflect the duality of its task: it must look forward as well as back.

Even if it is admitted that extrapolation is difficult, there is one forecast that is almost incontestable. If there is a civilisation in the 21st century, it is certain that science will be even more important than it is now: it will be dominant. The 20th century will be called the age in which dilettantism died: when the forming of opinion became a science, a job for the expert critic, just as the control of populations and the composition of a superior Irish stew had become a science. Not only will the men of the 21st century need more science, they will need a better science as well: a scientific attitude, rather than a state of knowledge, transfused into a broadening base of population that increases from year to year like the base of a volcano pushed through the crust of the earth.

That broad basis will be the product of a mass education, distasteful as this may appear, a mass education for which the foundations are being laid today, consciously or unconsciously; aimlessly or with a definite purpose. It is not a "bulge" in school population one has to plan for today, but the broadening base of scientific education.

It appears that in a democratic society people are unwilling to spend more than about three per cent of the gross national product on education. A totalitarian state (the USSR) is spending six per cent, and is asking for more. Without resorting to totalitarian methods, it must be realised that the material basis of an education is severely limited, and can be increased only if there is a profound change in people's attitude towards education. That is happening in the United States now, where the first Russian satellite brought the shortcomings of the educational system into painfully and perhaps absurdly sharp focus. There are 27 pupils for every teacher in the United States, 31 in the United Kingdom, 45 in France. In Russia there are 17. Without entering into arguments about the quality of teaching and the aims of the syllabus, it is necessary to keep in mind the available material basis of a mass education.

Some very difficult questions must be asked, and answered, in this light. Will it be possible to avoid early specialisation of students on a "three per cent" budget? Can the country afford to carry on a liberal education on such a budget when the requirements of the age are scientific? Or will it be necessary to resort to "training brains," as in Russia, leaving education to private life? Or, if none of these solutions is acceptable, will it be necessary to spend more, and if so, how best to use the money? Spend it on teachers at university level, or on students in the secondary school? Without answering these questions the new syllebus of the Science Masters' Association will not fulfill its "forward looking" function, it will be a guidance system that has lost sight of the target. The target is 40 years away, somewhere in the 21st century.

Cover Picture.—*A gas-turbine compressor being prepared for running in a decompression test cell.*

(Nurnberg photograph for ENGINEERING*)*

Plain Words

In the halls of the three great engineering institutions hang the portraits of some of their illustrious past Presidents. Many of them were the industrial giants of the 19th Century.

There are other names, less widely known, such as that of the former Editor of ENGINEERING, Dr. W. H. Maw, who conducted the editorial side of this journal for 54 years, from 1870 to 1924. He was President of the two senior institutions—a rare honour.

Few, apart from members of the institutions, ever have a chance to see portraits of famous engineers, although there is a national centre of pictures of top people of the past—the National Portrait Gallery. It is in the same block of buildings as the more famous National Gallery, but does not have the advantage that the latter has in fronting squarely on to Trafalgar Square. Comparatively few people visit it, compared with the numbers who visit the National Gallery and the Tate Gallery. I went round it myself last week, hoping that by ignoring the rather Victorian atmosphere of the place I might recapture some of the vanished glories of our forbears.

There are some splendid things. A massive bronze bust of Chesterton almost guards the entrance. There is a group picture of "Lord Kelvin, James Thomson and Mrs. Elizabeth King," and the three famous group pictures of "Some Sea Officers of the War of 1914-18," "Some General Officers of the War of 1914-18," and "Some Statesmen of the War of 1914-18." Among the statesmen in that picture is the youthful Churchill—or so he seems today, to us who associate him much more with the Second World War.

George Stephenson is there, but not Robert. The Brunels are both honoured. So is Joseph Bramah, described as an inventor (does anyone call himself that today?). Arkwright, Boulton and Watt, Richard Trevithick—there is a fair sprinkling of engineers and quite a few scientists. Practically no business men, unless they happen to have entered politics or some other respectable realm.

But the omissions I particularly wish to mention are the names of two engineers of this century, eminent enough to justify inclusion in the National Portrait Gallery. I think it is time we included Sir Charles Parsons and Sir Henry Royce. Who can come to the rescue, and perhaps at the same time present the gallery with some money to overhaul its decor?

Given the right presentation, there is more there to interest this personality-conscious generation than anything the butler ever saw.

CAPRICORN

Weekly Survey

Engineers Still Too Few

An almost static number of scientists and engineers employed in defence departments, and significant increases in their numbers in such industries as shipbuilding and precision instruments, is the encouraging news of the second survey of Scientific and Engineering Manpower in Great Britain, made by the Advisory Council on Scientific Policy's committee on scientific manpower.

In the three years reviewed, 1956, '57 and '58, the number of qualified scientists and engineers employed in Britain rose by 6 per cent. This left in 1959 some 6,000 vacancies in manufacturing industry alone and the employers have informed the committee that they would like an increase in the next three years of 7 per cent.

Back in 1956 the committee predicted that 36,000 engineers and scientists would qualify and in the result the figure has been 41,000. In the next three years the first effects of the expansion of the universities and the technical colleges and the introduction of the diploma of technology will be making themselves felt and the committee expect over 51,000 engineers and scientists to qualify.

Time alone will show how accurate this forecast will turn out to have been, but at 51,000 the output will be below the employers' forecasts of their needs by more than 5,000.

The total of engineers and scientists needed in Britain by 1962 is predicted as 211,700, which is 38,700 above the present requirement. Counting in 14,400 to replace wastage, the total of new men and women wanted will be 53,100. The exact total qualifying in this period is put at 51,650. (40 per cent of them people admitted to membership of the main professional institutions, the others university graduates, holders of the diploma of technology or associates of certain higher educational institutions.)

But some of those qualifying will emigrate and others return to their home countries, leaving in Britain a total of 47,500. Some of the margins between the predicted figures and the final results, and the acceptance of these at their Press conference in London by Sir Solly Zuckerman, chairman of the committee, and Professor Sir Alexander Todd, chairman of the Advisory Council on Scientific Policy, indicate that too exact a fulfilment of their new prophecies should not be looked for.

But nothing in the statistics remotely suggests a doubt as to the correctness of their conclusion, that the shortage of mathematicians, physicists and chemists will continue.

That it is too much of a good thing is inferred in the committee's reflections on the numbers of biology graduates. It does not see much hope of employment in industry for such graduates unless they have a post-graduate degree. The recommendation is made that those graduating in biology would do well to add another subject, perhaps mathematics or one of the physical sciences; this could lead to graduates without the necessary strength for success in their main subject and with too light equipment for competition with others more heavily qualified in mathematics and the physical sciences. But there are opportunities for biologists abroad and diversity of accomplishment will there be an obvious assistance, even if this is a prodigal way to use our all-too-few university places.

Movement of Engineers

The manpower committee's report repeated the pattern of the 1956 survey, that two-thirds of all scientists and engineers in manufacturing industry were concentrated in four groups—chemicals, other plant and machinery, electrical engineering and aircraft manufacture—groups which between them account for only one-third of all the employees in manufacturing industry.

The increase from 1956 to 1959 of scientists and engineers employed in manufacturing industry, 30·2 per cent, was 7 per cent behind the employers 1956 forecast of a 37·2 per cent increase in requirements. Some of the increases are particularly significant as pointers to future movements and perhaps of gathering momentum in the efforts to meet competitive conditions.

The second largest increase was a 60·1 per cent jump in numbers of scientists and engineers in shipbuilding, ship repairing and marine engineering. While this is something of an answer to recent strictures on the shipbuilders policies the proportion of scientists and engineers in this industry, 0·6 per cent (0·4 in 1956) is still low compared with chemicals and allied trade, 3·7 per cent, or aircraft, 2·7 per cent. The shipbuilding group had 63 vacancies for scientists and engineers in January this year, compared with the massive vacancy list of 1,687 in electrical engineering, 650 in chemicals and 901 in aircraft.

These vacancy figures may not be as good a guide as all that to where the bright future lies for engineers. As Sir Solly Zuckerman said: "The parent who looked at this and put his boy into electrical engineering might find he came unstuck."

The largest increase over the three years came in precision instruments where the percentage rise was 87·3 to a total of 1,425 employed. The third increase in a group known as other plant and machinery (but which excludes motor vehicles, iron and steel, agricultural and constructional machinery and electronics) was of 51·6 per cent to a total of 10,087 employed.

Of the 23,600 engineers and scientists coming into employment since 1956 in the fields covered by the survey of that year 69 per cent of the engineers and 53 per cent of the scientists have gone into manufacturing industry, 17 per cent and 9 per cent have gone into nationalised industries and public corporations and 6 per cent and 32 per cent into education.

While the percentage increases that a whole list of industry groups expect to see in scientific and engineering employment in the next three years are quite appreciably below what they forecast in 1956, the next three-year forecasts are far below what was achieved in practice.

Taking the groups individually, chemical and allied trades forecast a 20 per cent increase in 1956 and achieved a 45 per cent, but for 1959-62 predict only a 17 per cent rise. The same three figures—1956 forecast, actual increase up to 1959 and three-year forecast up to 1962—are:

Precision instruments	60,	87,	32
Non-ferrous metals	37,	25,	12
Mineral oil refining	47,	50,	18
Food, drink and tobacco	25,	34,	15

The shipbuilding, repairing and marine engineering group, having looked forward to an increase of 11 per cent in scientific and engineering employment in 1956, in fact recruited 60 per cent more but now looks forward to only an 11 per cent rise up to 1962.

Steel at Durgapur

Durgapur iron and steel works, the first stage of which is now complete, represents to Britain and India much more than just another large integrated steelworks. To India, it is another step in the Government's plan to transform the country's economy in the near future. To Britain, Durgapur symbolises a type of export business which is still young, but of increasing importance: the export of complete manufacturing

plants, together with the skill to operate them.

Costing some £100 million, about half of which is being spent in the United Kingdom, Durgapur is an outstanding example of co-operation. No single British firm makes all the equipment needed, and 13 companies, some of them normally competitive, are cooperating in the consortium ISCON (Indian Steelworks Construction Company Limited) which is building the plant. This cooperation, involved enough in itself, is complicated by the need to coordinate the work of many other concerns, including many in India, which are contributing plant, materials or services. In addition, the training of senior staff to man the plant on completion has to be undertaken simultaneously with construction, and this involves the assistance of many firms which are not, themselves, necessarily concerned with the supply of equipment. Young Indian engineers and metallurgists are receiving specialised training in various British steelworks, a procedure which is part of the programme of technical assistance arranged under the Colombo Plan.

Smooth operation of such a complicated group of arrangements for designing, transporting, erecting and installing machinery, and training staff show how successfully British firms can and do cooperate, though it is not unknown for them to be accused of refusing to do so.

Durgapur points, too, the way to future possibilities. As overseas countries develop their industrial programmes, there will be opportunities for groups of British manufacturers to engage to construct more complete plants for making steel, and other products. That the business will be there is reasonably certain, but it will not be available simply for the asking. Other countries besides Britain—Germany, Russia and USA, for example—are ready and willing to take on such work. The prizes will go to those who can not only do the work satisfactorily, but also offer acceptable terms for payment. Thus cooperation comes into the field again. In the case of Durgapur, the British Government and British financial concerns have joined in the scheme, by providing credit. Future projects of similar scope will need similar arrangements.

Not Enough Swiss Money in Oil?

The Swiss, as every schoolboy knows, have a federal constitution. From time to time the independence that this gives to the Cantons conflicts with what the Federal Government conceives to be the best interests of the country as a whole. This has happened in the past few months in connection with the search for oil. In July the Fribourg Cantonal Government granted an exploration concession to the wholly owned Société d'Intérêts Miniers on the understanding that it would come to a working agreement with BP, which already had a seismographic team at work. The agreement provides that BP will spend 22·5 million Swiss francs on exploration in the next nine years of which 5 million Swiss francs will be spent in the first three years. Federal Government policy is in favour of oil exploration so long as it is under the effective control of Swiss capital. This proviso stems from the fear that as BP will be providing most of the money there is the chance that Swiss neutrality might be endangered in the event of war.

This view is challenged by many Swiss as out of touch with modern conditions, but the Federal authorities nevertheless cling firmly to it. Since the Cantons have the say-so in the granting of oil concessions the Federal Government can only advise or express disapproval. A recent attempt to amend the constitution to give supervisory powers over exploration and production of crude oil to the Federal Government failed. The Cantons have, however, agreed to serve on a special oil committee. Another move to enforce the Federal Government's policies is the setting up of a new company called Swiss Petrol Holdings AG. This will help finance oil exploration in Switzerland by companies having Swiss majority holdings.

The same interests are involved in this new concern as in SEAG, the Swiss oil company, which is owned 75 per cent by Swiss industrial and banking interests. SEAG has an extensive exploration area in north-east Switzerland. Another oil development facing the Swiss is the proposed pipeline from Genoa to Aigle and a refinery at Aigle. The Italian state-owned ENI is involved in both projects. Swiss interests have put up the majority of the capital for the refinery, but have only a small investment in the pipeline. Here, however, it looks as though the Federal Government will not stand on its dignity over a development that is clearly to Switzerland's advantage.

Neglected Opportunities

More or less unnoticed in the acclaim given to the recent freeing of dollar imports into Britain, the Government increased licensing restrictions on trade with China and took a number of quota steps.

Now Lord Boyd-Orr, one of whose positions is president of the British Council for the Promotion of International Trade, has caught up with the authorities, making a sharp attack on these moves at the Council's annual general meeting. They were, he said, a very severe blow to trade with China. Trade with China had been increasing from year to year and showing a balance in favour of the United Kingdom, and the new measure could only have a hampering effect.

Recalling that the Council had for long urged a government-to-government trade agreement with the Soviet Union, Lord Boyd-Orr said that they welcomed in principle the agreement signed after Mr. Macmillan's Moscow visit but its scope and value were altogether too limited and bore very little relation to the real possibilities of trade between the two countries.

Lord Boyd-Orr instanced the well-known displacement of this country by Western Germany from second place in the list of world exporters of manufactured goods and the Board of Trade's statement that we were not maintaining our share of world exports in manufactured goods. This was evidence that if only from self-interest Britain should be giving greater attention to the markets of what he calls the "planned-economy countries."

In the past one of the arguments against Lord Boyd-Orr's case has been based on strategic materials. This applies with less and less weight when Western Germany is so rapidly pushing up her share of exports to Soviet bloc countries. Including those to Eastern Germany, such exports by Federal Germany in 1958 exceeded those from this country by £122 million.

Federal German exports in 1958 to China were worth £58 million against exports worth £27 million from Britain. Either figure is only the trickle before what could become a great stream as the Chinese "Great Leap Forward" lifts living and spending standards among more than 500,000,000 people. Mr. McFadzean, the president of the Federation of British Industries, has commented on this when he said that it was no longer possible to make the excuse that the West Germans had "inherent advantages which outweigh those we possess." The FBI president claimed that in price, service and quality we were competitive with the Germans, but in salesmanship were falling down.

Advocating Government support for exporters in these fields, Lord Boyd-Orr wanted improved credit facilities and, as we should be dealing with State Banks at less risk than in many other markets, and a Government loan—"which would guarantee many millions of pounds worth of additional exports, mostly of engineering goods." If the Government would not do it then a private banker should launch such a scheme, as a merchant bank has recently done for trade with Scandinavia.

Letters to the Editor

NOW OTHER DAMS COULD FAIL

SIR, Last June, I wrote to a leading London newspaper seeking its good offices to give due warning that we should be ready to face a serious drought. Unfortunately that paper had not space for its publication. Last October, I again wrote pleading with the editor to draw attention to the increased risk of dam failures. Since then the French dam disaster has taken place.

Those of us who practise the art and science of dam design and construction feel very much with those who have suffered in the French disaster and, in particular, with the designer. Until the facts have been properly examined it is wrong to try and come to any conclusion as to the causes of this failure.

In the interim, however, we in this country should be aware that following the severe drought of last summer and the continued prospects of heavy rains this winter, the general factor of safety of earth dams, containing a high proportion of clay, is probably approaching its lowest level for a considerable number of years. Thirty-four years have elapsed since the Dolgarrog failure in North Wales, the longest gap in time in British history without a serious failure.

May I suggest, therefore, that those responsible for the maintenance and operation of dams and embankments of all types should be especially vigilant during the coming months, for through vigilance what might be a disaster may be reduced to a minor incipient failure.

Yours faithfully,
DELWYN DAVIES,
Member, Panel I, Reservoirs (Safety Provisions) Act.
473 Chester Road, Hartford,
Northwich, Cheshire.
8 December, 1959.

THE JET PROVOST

SIR, I must protest most strongly at the article entitled "Flutter, Roll and Fatigue" (ENGNG., 20 Nov. '59, p. 512). This, and particularly the captioned photograph of a jet Provost and the sub-heading "Fatigue in the Provost's Tail," are calculated to convey the impression of unexpected and fatal weakness in our jet Provost T.Mk.3 trainer now in service with the Royal Air Force. The truth is far otherwise.

In fact, the tail strain gauge tests at the RAE, which were the subject of Mrs. Burns's paper referred to in your article in question, were carried out on a development aircraft as part of a carefully considered programme to ensure that the jet Provost would have an exceptionally long fatigue life. With the aim of obtaining an accurate loading spectrum for design and fatigue test purposes, this strain gauged aircraft was flown through all the aerobatic and other manoeuvres required in RAF service. Analysis showed that, from the fatigue standpoint, the most important loads occurred during spinning. Moreover, as stated in the introduction to Mrs. Burns's paper, the tests fitted into an overall survey of flight loads on tail units in showing the trend for various manoeuvres in aircraft generally.

The results were carefully considered in designing the tail of the jet Provost T.Mk.3, and the buffet conditions noted by Mrs. Burns were considerably alleviated. On subsequent fatigue testing, the tail unit was taken to the equivalent of more than 35,000 flying hours without failure, the test being then discontinued as it was felt adequate fatigue life had been proved. I think this speaks for itself.

The above are the true facts. In the circumstances, I feel you should give them adequate publicity.

Yours faithfully,
F. H. POLLICUTT, Technical Director.
Hunting Aircraft Limited,
Luton Airport, Bedfordshire.
8 December, 1959.

More Letters on next page

XUM

GAS COOLED REACTORS

SIR, I was delighted to learn from the Leader in your issue of 23 October that you are in favour of collaboration between the United Kingdom and Canada on reactor development. I have also read the letter from Mr. G. E. Preece of the de Havilland Engine Company in the same issue with great interest and would like to comment on it.

I agree that the three possible ways of dealing with the gaseous and volatile fission products in a high-temperature gas-cooled all-ceramic reactor are generally as described by Mr. Preece. But I do not believe that the incorporation of a fission-product scavenging system need necessarily impose any restrictions on the design of the fuel elements or introduce metallic components or other pipework that might compromise the core design.

In the Daniels-Boyd nuclear steam generator that portion of the fission product scavenging system that is within the reactor envelope is formed by passages within the graphite blocks, some of which would be there in any case. The horizontal collecting headers on the top of the reactor are made of drilled graphite blocks and the pipes which convey the contaminated helium to the purification system are made of carbon steel, externally cooled and internally lined with commercial carbon, which is a thermal insulating material.

Our scavenging system is a dynamic, rather than a static one in which there will be a substantial flow of helium. This flow, however, is quite a small percentage of the main cooling gas flow and it will be induced by Corblin pumps located on the downstream side of the purification system. Thus the scavenging system passages within the reactor do not have to be gas tight as leakage will be into the system rather than the reverse. This also means that the gas of the entire cooling system will pass through the combined scavenging and purification system at a rate equal to the full volume of the main cooling circuit every 24 hours.

We appreciate that such a scavenging system may not keep the main cooling gas absolutely free of contamination. That is why the D-BNSG also has a completely shielded and highly leak-free main cooling system. And it is also the reason why quite elaborate provisions for the removal and replacement of blowers, control rods and charging machinery have been provided.

The carrier helium in the scavenging system will leave the reactor at a temperature between 1,500° and 1,800° F. We have therefore assumed that only those fission elements which have boiling points below 1,660° F will appear in the scavenging gas. These elements are zinc, arsenic, selenium, bromine, krypton, rubidium, cadmium, iodine, xenon and caesium. All the other fission elements have boiling points well above 1,660° F., the lowest being that of strontium which is 2,520° F. We have therefore assumed that they will remain within the fuel elements as either liquids or solids and in their elemental forms or as carbides.

Of the low boiling point fission elements the important ones, as far as the scavenging system is concerned, are caesium, bromine, iodine, krypton and xenon. These will be easily transported by the hot scavening gas to the purification system. The remainder of the low boiling point fission elements (zinc, arsenic, selenium, rubidium and cadmium) are not a scavenging problem because of their minute yields and/or very short half lives.

Of the five important low boiling point fission elements, caesium will be the most troublesome if it gets into the main cooling system. This is because of its melting and boiling points (82½° and 1,274° F respectively) which mean that it will condense in the cool portions (450° F) of the main cooling system, thereby contaminating the main blower impellers and related parts.

Although we have made provisions to remove and replace heavily contaminated blowers and other parts, any reduction in this contamination effected by the scavenging system will ease the maintenance problems of these components.

We fully realise that a certain amount of specific development work will have to be done on the scavenging and purification systems as well as on certain other parts of the D-BNSG. But we feel that the actual amount of such work is not nearly as great as generally believed because of the work on similar problems already being done in other countries and because of the marked similarity between the "hardware" of the D-BNSG and that of the present generation of British power reactors.

We therefore believe that the great promise inherent in the D-BNSG for very substantially reduced specific capital costs and considerably lower unit fuel costs (because of no sheathing) without having to resort to an extensive development programme will not go unrecognised for long. We therefore hope that Canada and Britain, either individually or jointly, will be among the first to recognise and exploit its tremendous potential.

Yours very sincerely,

WINNETT BOYD.

Winnett Boyd Limited,
745 Mount Pleasant Road,
Toronto, Canada.
30 November, 1959.

CHOICE CARS

SIR. Your article entitled "Choosing an Economy Car Statistically" is timely (ENGNG., 27 Nov.'59, p. 540). I attempted selecting a car statistically some years ago and my approach might be of interest even though car prices in Ireland, due to home assembly and the use of some Irish manufactured parts, are different from British prices.

My car requirements are: a four-seater saloon, mostly for city and suburban use, but also for occasional journeys of up to 300 miles; sustained speeds up to 75 m.p.h. are required occasionally; and comfort with safety is a must.

In 1954, the cars costing less than £600 then available in Ireland were detailed in *Motoring Life*. Based on this, I set about finding a car which would suit my particular requirements. My approach was to consider the cost price of the various cars, to assume 10,000 miles annually for 4 years and to estimate the cars' secondhand prices then. The tax, insurance and petrol costs for the 4 years were estimated (the cost of oil, tyres, servicing repairs and replacements were neglected, as these costs ordinarily would be reasonably common for all the cars considered). Adding these costs, the 4-year part total cost for the different cars was obtained.

The attached Table lists the Irish 1954 car prices and the above 40,000 miles part total costs. If one is interested only in transport from one point to another the Ford Popular would be the choice. In my case I was interested also in acceleration, maximum speed, top gear speed per 1,000 r.p.m., number of gears, wheelbase, track, turning circle, passenger and luggage space, basic extras included in the price and special features like front-wheel drive, independent suspension, etc. I gave arbitrary money values to each of these parameters, weighted each in accordance with what I considered my particular requirements dictated and obtained the "value" figures shown in the Table. It will be seen that the arbitrary money values I selected for the parameters considered result in one making money by selecting any of the first five cars!

TABLE.—*Irish Car Prices and "Part Costs" in 1954*

Car	Irish price in 1954 £	Part cost for 40,000 miles £	"Value" £	Part cost less "value" £
DKW 900 c.c.	549	620	775	−155
Austin A40	560	660	756	− 96
Hillman Minx	525	657	736	− 79
Volkswagen	499	604	660	− 56
Ford Consol	585	736	773	− 37
Ford Anglia	460	578	471	+107
Standard Eight	438	508	387	+121
Morris Minor	439·5	504	375	+129
Austin A30	439·5	512	317	+195
Renault 760	520	600	380	+220
Fiat 500C	395	481	250	+231
Ford Popular	350	476	218	+258

My investigation indicated that my choice should be the 900 c.c. DKW; so I purchased this car in 1955, then costing £600. Its two-stroke, three-cylinder, water-cooled engine appealed to me, as did also its front wheel drive, its free-wheel, and its extras.

I purchased my second 900 c.c. DKW last year at £720 and both have given every satisfaction. Incidentally the average annual consumption on commercial petrol was 35 and 37 m.p.g. for the two cars, respectively, compared with the 26 m.p.g. in your article; overall oil consumption is 1,400 m.p.g.

In your unweighted evaluation chart, the 1,000 c.c. DKW (Auto-Union) is near the end. This is not surprising as its price in Britain (£1,241) is more than twice the price of many of the other cars. British buyers of DKW's must weight their favourable parameters even heavier than I do! It would be interesting to see how the 1,000 c.c. DKW evaluates with cars in the 1½ litre class, as it is more comparable with these.

Very positive proof of the statement in your article that the various parameters are differently weighted by different buyers is given by the strange facts that the British motorists are buying Dauphines at £716 when Heralds are available at £702, while Irish motorists are buying Heralds at £675 when Dauphines and Volkswagens are available at £549 and the Fiat 1100 at £625.

Yours faithfully,

P. G. BOYD.

30 Greygates,
Blackrock, Co. Dublin.
8 December, 1959.

New Plant and Equipment

MACHINE VICE

THE Camgrip vice claims advantages on account of its simplicity and speed of operation.

There is no screw thread so that adjustment of work size is very rapid. The moving jaw slides on two guide bars that are machined parallel to the base so that work resting on them is also parallel to the machine table. The space below the jaws is clear.

With the clamp lever in the vertical position, the moving jaw can be adjusted by the slide lever through 2¾ in. When set against the work the clamp lever is pulled down and an eccentric cam on it grips the adjusting rod. *Hill and Company (Tools) Limited, Eastbourne Road, Polegate, Sussex.*

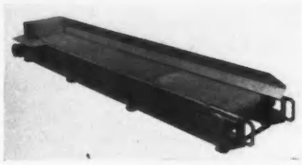
FIXING PINS

DEVELOPED for fixing timber to masonry is the Obo series of pins which do not need the wall to be plugged.

The pins are made from tough steel and can be hammered into most masonry using an ordinary hammer, without prior drilling or plugging or any additional tools. They can be used for such jobs as fixing pelmets, skirting, hardboard, battens for shelving, acoustic tiles or pegboards. The pins are made in five sizes from 1⅛ in to 2¾ in long. It is recommended that at least 1 in should penetrate the masonry, except on soft walls or where there is a great depth of plaster, in which event a longer size should be used. *Douglas Kane Limited, 243 Upper Street, London, N1.*

TRANSPORTABLE CONVEYOR

Electric Drive



THE transportable conveyor illustrated has been designed primarily for work in mines.

It can be used for the maintenance of stable holes in advance of the coal face to remove coal and stones over a short distance while working in a confined space. The conveyor is designed for an 18 in wide belt. It is driven at the tail end by an electric motor combined with the drive pulley assembly and at the delivery end by a tensioned return pulley.

The frame is fabricated from mild steel sheets which form a trough for the top belt and at the same time provide complete protection for the bottom belt. A hopper is fitted at the loading end to receive the material. Removable spill plates are fitted for the full length of the machine at one or both sides as required. The whole unit is moved by sliding on the tubular steel skids.

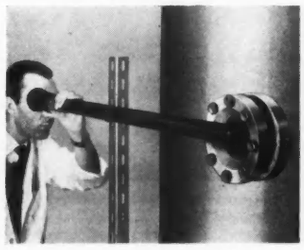
The motorised driving drum is rated at 2 h.p. and incorporates the electric motor and reduction gearing. The motor leads are brought out to a junction box fitted with a standard 30 A restrained type FLP plug and socket, so that the conveyor can be run from a standard drill panel.

The belt supplied is a pvc 3 ply 32 oz Tugron duck with $\frac{1}{8}$ in top and back covers. Normal drum centres are 10 ft but other lengths may be made to suit special applications. There is provision for an adjustment of up to 3 in to be made.

The rated capacity of the conveyor is 50 tons of coal per hour and the belt speed is 175 ft per minute. The overall length is 11 ft 6 in and the height 18 in. The width is 2 ft 10 in. The weight is 6 cwt 30 lb, which is reduced to 5 cwt 24 lb if the spill plates are removed. Standard supply is 125 V at 50 or 150 cycles. *Richard Sutcliffe Limited, Horbury, Wakefield.*

PERISCOPE

For Safe Viewing



A SAFETY periscope has been added to the range of optical equipment made by P. W. Allen.

The instrument is designed for the observation of equipment and processes through sight glasses, as in pressure vessels, furnaces, chemical plant, and the like, where the fracture of the glass might cause injury to the observer. By using the periscope he can stand well clear of the window.

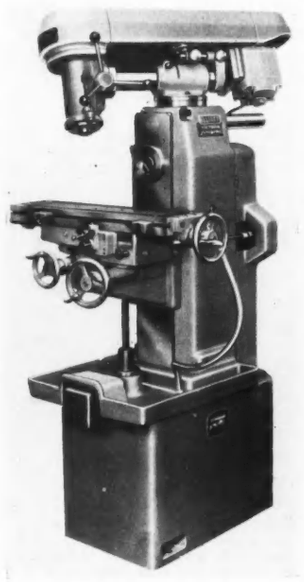
The model A201 consists of a periscope optical system of unit power with a field of view of 35°. It is fully corrected and free from distortion. The optics are contained in a tube of metal 30 in long and $1\frac{1}{2}$ in diameter fitted at one end with a rubber eye shield and a focusing sleeve, and at the other with a 90° prism. Any object further than 3 in from this prism and up to infinity can be focused, and there is considerable depth of focus at any setting.

For those situations where the periscope has to be held horizontal and at a level below that of the eye, or where it has to be held upright to reach a window above the observer, a 90° eyepiece can be fitted. Also available for use with the instrument are low voltage high intensity spot lights that will fit on the end of the periscope and will illuminate the inside of vessels that are without internal lighting or are too dark to see properly.

The A201 safety periscope is supplied complete in a fitted wooden carrying case. The 90° eyepiece is an extra, but a standard item. The spotlights are made to order only to suit customer requirements. Although light in weight a support should be used for prolonged inspections. *P. W. Allen and Company, 253 Liverpool Road, London, N1.*

MILLING MACHINE

Tilting Head



THE Junior Omnimil is the Juniormil milling machine to which has been added an inclinable head, making it suitable for boring, drilling, and milling at all angles.

The vertical head is mounted on a round over arm which is supported in a turret on the column. It can be swivelled in a horizontal plane and traversed in the turret. The drive to the spindle is taken from a $\frac{3}{4}$ h.p. motor through stepped pulleys that offer a choice of 7 speeds, from 200 to 3,600 r.p.m. The quill is provided with a rack for manual down feed, and is spring balanced.

The working area of the table is 28 in by 7 in and the movements are 17 in longitudinal; 6 in cross; and 12 in vertical. There is a choice of 6 longitudinal feeds. The coolant tank is in the base, the pump being belt driven. The feed hand wheels are calibrated in 0·001 in divisions. Trip dogs can be used to disengage the longitudinal feed. *B. Elliott (Machinery) Limited, Victoria Works, Willesden, London, NW10.*

SHELL MOULDER

25 moulds per hour

THE Reynolds shell moulding machine will produce 25 complete moulds per hour with only one operator.

The machine has two investment boxes and two heating units for making the two halves of a mould. The boxes are positioned at each end of a steel framework which has at the centre an idling position for the heaters. The framework provides a horizontal track on which the pattern plates, mounted on rollers, can be moved quickly from the heating positions to their respective investment boxes.

The heating units are fitted with electric elements providing rapid heating by radiation. They are suspended from a rear framework and are easily moved in any direction to align them over the pattern plate.

When a pattern plate has been heated to the required temperature the heating unit is removed to the idling position. The plate is moved to its investment box and tilted at the proper angle for securing to the open end of the box with quick acting clamps.

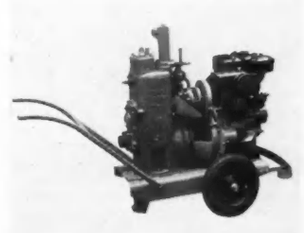
For the next stage, the investment boxes are upended with large diameter hand wheels to provide the dumping action which compresses the sand to the shape of the pattern.

After a period of from 8 to 15 seconds, depending on the thickness of shell required, the box can be moved back to its original position and the invested pattern plate returned to the track where it is again covered with a heating unit to complete the curing of the resin impregnated sand.

The cured shell is finally stripped from the pattern by spring loaded plungers that are brought into action by a foot lever. The moulding machine will make shells up to 18 in by 14 in. *Electric Resistance Furnace Company Limited, Netherby, Queens Road, Weybridge, Surrey.*

CENTRIFUGAL PUMP

Liquids or Slurries



THE latest addition to the range of Sykes pumps is the Univac UVS2, a 2 in centrifugal pump for handling solids in suspension or slurries.

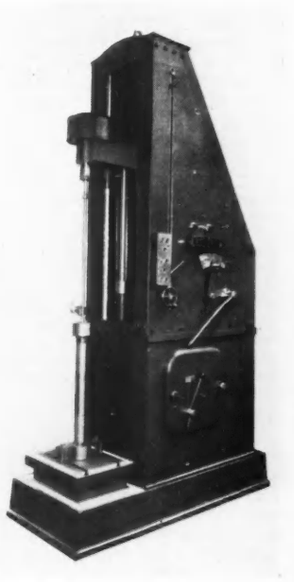
Unlike other models in the Univac range, the UVS2 will be available from stock. It is claimed to have very rapid priming and to need no priming water. Very long suction pipes up to 300 ft can be used. The pump will pass solids up to 1 in diameter and will work on snore for the maximum suction lift of 28 ft. It has a three bladed corrosion resistant impeller running at 1,500 r.p.m. Outputs range from 6,500 gallons per hour at a vertical suction lift of 10 ft to 3,300 gallons per hour at lifts of 26 ft. At a total head of 39 ft the output is 3,000 g.p.m.

The pump is driven directly by a Lister diesel engine type LD-1 running at 1,500 r.p.m. and developing 3 b.h.p., continuous rating. Alternatively it can be driven from an electric motor of the same power. The standard model is mounted on a steel barrow as shown, with two 14 in by 3 in cushion tyred wheels. Without the handles it measures 3 ft 6 in long by 2 ft 5 in wide and 3 ft 6 in high. With the diesel engine the net weight is $5\frac{1}{4}$ cwt. The electrically driven model is $1\frac{1}{4}$ cwt less.

The standard form of the pump is arranged to take heavy duty coarse thread hose unions which conform to BS1782. These have 6 threads per inch and it is said to be impossible to cross the threads. Hoses available are $2\frac{1}{2}$ in bore 3 ply corrugated heavy duty rubber and canvas with a semi-embedded internal helical wire and a further fully embedded wire. *Henvy Sykes Limited Southwark Street, London, SE1.*

CYLINDER HONE

Independent Motions



THE Armstrong type H2 cylinder honing machine is made in three sizes, with strokes of 20 in, 40 in and 60 in. The rotary and reciprocating motions can be operated independently.

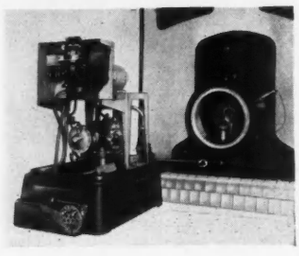
All motions can be controlled from one position. Provision for local honing at any point in the cylinder has been made and the hone may be withdrawn to the extreme top for gauging and reloading. The table is supplied to suit the product.

The whole of the rotary drive is mounted on a sub-plate and comprises motor, V belt drive, oil-immersed plate clutch, four-speed gearbox, and bevel drive to the vertical shaft. The final drive from the splined shaft is by multiple V belts giving a very smooth motion. The crosshead receives its motion from a hydraulic cylinder and ram situated centrally between the guides. The control valves are of the balanced piston type. *Payne Products International Limited, Lawrence Estate, Green Lane, Hounslow, Middlesex.*

XUM

OIL BURNER

Heavy Grade Fuels



THE MacFlame series of packaged oil-firing units has been designed to burn heavy grade residual fuel oil with a viscosity of 960 seconds Redwood.

The equipment consists of two units, a free standing console for the auxiliaries and a boiler front plate assembly. Both are covered by glass fibre housings. There are five models to cover the range from 1,450,000 to 5,500,000 Btu per hour.

The console unit measures approximately 3 ft 6 in high by 3 ft deep and 20 in wide, and houses an electrically driven air compressor, fuel metering pump, fuel filter, cut-off valve, an high tension transformer and the control unit. A line heater for the fuel is built in to the base of the console. It is fitted with control and over-temperature thermostats. The arrangement is said to give ease of cleaning.

The control unit incorporates a sequence timer, a starter for the motor, a flame failure relay designed to fail safe under all conditions, and sequence indicating lights. The lights, the on-off switch, and the reset switch are visible from the outside of the cabinet. The boiler front plate assembly incorporates a medium pressure air atomiser, flame failure control viewing head, HT ignition unit and automatic purge and circulating control. Each of the five models is available in three forms. The Automatic with on-off control; Auto-Hilo with on-low-off system, and the Auto-Ratio which is fully modulating. It is claimed that the noise level is kept low by the front plate cover which acts as a sound attenuator. *Urquhart's (1926) Limited, 5 Wadsworth Road, Perivale, Greenford, Middlesex.*

TENSION METER

For Wire or Wool

NOW being made in this country, the Saxl tension meter—although mainly used in spinning and weaving processes—can be applied wherever it is required to measure the tension in a strand that can be either stationary or moving.

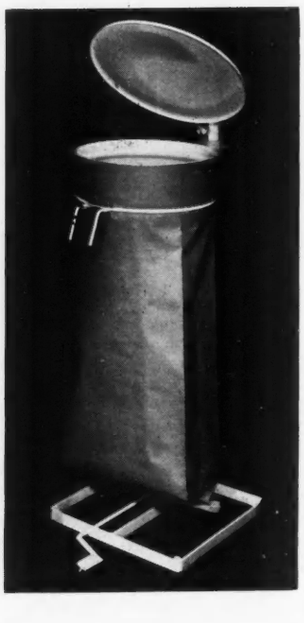
In use the trigger is pulled to open the rollers and the strand or tape is passed between rollers and the grooved guide. Releasing the trigger allows the gauging rollers to close on the strand. One roller is spring loaded and this is slightly deflected from its normal position by an amount corresponding to the tension in the strand. The displacement is transferred by a train of gears to the dial which is graduated to read directly in grams.

The pointer is made integral with a transparent disc, the inertia of which helps damping of oscillations to give a steady indicator reading. The rollers can be shaped to suit any particular thread tape or strand.

The instrument is made in four ranges, from 0 to 25g; from 0 to 125g; from 0 to 250g; and from 0 to 1,000g. Measurements can be made while the strand is actually running past the rollers without stopping the process. It can therefore give an accurate measure of operational forces. *Thomas Mercer Limited, Eywood Road, St. Albans.*

WASTE BINS

Disposable Paper Sacks



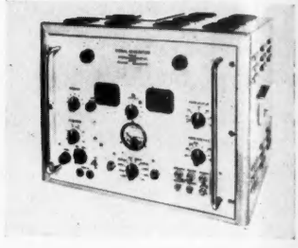
DISPOSABLE paper sacks make a hygienic waste bin for use in works, hospitals or catering establishments.

Four standard sizes of Medway sacks are available. These measure 25 in by 11 in by 5 in; 39 in by 14 in by 8 in; 39 in by 16 in by 13 in; and 44 in by 20 in by 12 in. They are constructed from 37 lb wet strength kraft with barrier plys for special applications, and can be coloured for identification.

For use with these sacks a range of holders is being made by Cartem Engineering Limited, 40A Dover Street, London, W1. The one shown in the illustration is wheeled and fitted with a pedal operated lid. Other models have hand operated lids or no lids at all, and include types for floor and wall mounting and for fixing to dressing trolleys or housemaids' trolleys. The holders are stove enamelled in white. A spring clip holds the sack in place and allows quick replacement. *Medway Paper Sacks Limited, Larkfield, Nr. Maidstone, Kent.*

SIGNAL GENERATOR

L Band Frequencies



THE signal generator model 957 has been produced to cover the L band range of frequencies and works from 800 to 2,100 Mc/s.

It is intended for laboratory and general use and, in particular, for spectrum analysis. The single dial control is calibrated directly to within ± 1 per cent. The frequency stability is good, the warm-up drift being less than 0·2 per cent and the ambient drift about 0·003 per cent.

The power output is from 0 to 100 db, continuously adjustable by a directly calibrated control relative to 1 mW. The absolute accuracy of reading is ± 2 db and the relative accuracy ± 0·2 db. The power is monitored by a temperature compensated thermistor bridge operating a panel meter. The output impedance is 50 ohms. An " N " type connector is used.

Modulation can be by external pulse; by internal pulse generator; by synchronisation to an external pulse generator; or by synchronisation to an external sine wave generator. The pulse width, delay, and rate can all be controlled. The sync outputs can be either delayed or undelayed but the latter is not available when modulating from external pulses. The RF pulse shape has a rise time of 0·3 μ sec and a decay time of 0·6 μ sec. The pulse is flat to within 10 per cent of the mean amplitude.

The power requirement of the instrument is 115 or 230V at 50 to 1,000 cycles, single phase; the consumption is approximately 200W. The case measures 17 in wide by 12½ in high by 12 in deep. The total weight is approximately 50 lb. *Winston Electronics Limited, Shepperton, Middlesex.*

CENTRELESS GRINDER

Using Wet Belt

A NEW centreless grinding and polishing machine uses a wet belt instead of a wheel.

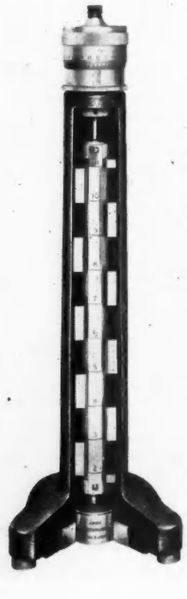
Particular claims are the fast removal of material (up to 0·01 in per pass) and the very high polish that can be obtained. Through feed or plunge operations can be used. To hold the work against the abrasive belt a second short belt is used, supported by a hardened steel plate. This belt can be inclined to the vertical and the inclination controls the traverse direction and speed of the work. Set vertically, the belt allows plunge grinding.

The belt can be run at three different speeds. Adjustable spring pressure moves the control head towards the grinding belt and a micrometer dead stop regulates the width of the grinding throat and therefore the diameter of the work ground. A foot lever is used to retract the head.

The belt is 6 in wide and runs over a tensioning and tracking pulley. Grinding capacity is from ¼ in to 2½ in diameter, and grinding feed up to 25 ft per minute. The abrasive belt speed is 5,000 ft per minute. The contact wheel holding the belt against the work can be changed to suit the support requirements. Pressure jet cooling is employed. *Taylor Tools and Supplies Limited, Vortex Works, Atlantic Street, Broadheath, Altrincham, Cheshire.*

HEIGHT GAUGE

Measures to 0·0002 in



HEIGHTS from 2 in to 12 in, to an accuracy of 0·0002 in, are covered by the Accuread micrometer height gauge.

The instrument has a large drum micrometer at the top with a 1 in movement. In the centre barrel are nine 1 in spacers with projecting tongues, and these spacers are spring loaded against the anvil of the drum micrometer. The projecting tongues are so arranged that over and under measurements are made in the same plane. The whole gauge weighs 11½ lb.

To measure the height of a top surface the stylus of a dial gauge is laid on the workpiece and then transferred to the upper surface of the appropriate 1 in tongue and the micrometer head turned to bring the pointer back to the original reading. Similarly, the underside of a tongue can be used to give a bottom surface reading. The Accuread is 17 in high and 5 in wide at the base. *Amar Gauge and Tool Company Limited, Grove Road, Chadwell Heath, Romford, Essex.*

TURBO-JETS AT LONDON AIRPORT

Several members of the House of Lords took part last week in a brief discussion on problems which have arisen at London Airport consequent upon the landing there of modern large long-range British and foreign turbo-jet airliners.

The matter was raised by Lord Ogmore (Liberal), who asked if the Government were satisfied that such aircraft possessed a sufficient margin of safety, when fully laden, on taking off or on approaching and landing at the airport. He pointed out that there was a modern tendency on the part of many aircraft operators to increase their loads to the maximum extent permitted by the aircraft certifying authorities of their various countries. He also understood that there were some competent authorities who were of the opinion that the requirements now in force were not sufficient to ensure safety under present conditions.

Lord Shepherd (Independent) asked if the Government were satisfied that the requirements laid down for taking off and landing at London Airport and Heath Row were being observed by the air lines concerned. Lord Rea (Liberal) asked whether the testing of the turbo-jets was carried out by Government departments or by the companies running these aircraft. Lord Ogmore said that it was not a question primarily of British tests. Earl Howe (Conservative) inquired if the Government were aware that the machines principally complained about were foreign machines and not British, and wondered if the turbo-jets kept to their height limit when in flight.

AMERICAN AND BRITISH TESTS

Dealing briefly with these points, Lord Mills, the Paymaster-General, said that safety requirements for the take-off and landing of the long-range turbo-jets using London Airport had been formulated after intensive investigations by the United Kingdom, the United States and the International Civil Aviation Organisation. The present requirements were designed to ensure that the aircraft had an adequate safety margin. The adequacy of the requirements was kept continuously under review by analysing the results of tests and of operating experience, and by the photographic analysis of operational take-offs and landings.

So far as British tests were concerned, these were conducted by the Air Registration Board and the Ministry of Aviation. He could hardly imagine that they did not take into account questions of height. The turbo-jets with which they were dealing were either British or American; and the same tests and procedures were pursued in regard to American machines as in regard to British ones. If he were given the names of the authorities who considered that existing safety requirements were insufficient, he would certainly look into the matter further.

JET AIRCRAFT CREWS

In the Commons, the Minister of Aviation was asked by Mr. Fenner Brockway (Labour) to give a general direction to British European Airways, in the interest of air safety, to include a flight engineer among the crews of all their jet aircraft. Mr. Brockway suggested that the composition of the BEA crews for these aircraft, as at present decided upon by the corporation, had been very strongly opposed by the flying staff section of the International Transport Workers Federation and by the Biritish Merchant Navy and Air Line Officers Association. He asked if it were not the case that the British Overseas Airways Corporation included a flight engineer.

In reply, Mr. Duncan Sandys said that the only jet aeroplane in the BEA fleet was the Comet IVB and that the Certificate of Airworthiness for that aircraft provided that the crew to operate it should consist of either three pilots or two pilots and one flight engineer. He had to be guided by the views of the Air Registration Board. They had left the alternative to the airlines of having either three pilots or two pilots and one flight engineer. The fact that other airlines had chosen the alternative did not seem to him that the BEA were necessarily wrong.

Later, he told Mr. Anthony Royle (Conservative) that he had decided that No. 5 runway at London Airport should be extended from 9,576 ft to 11,000 ft, to meet the requirements of the large turbo-jet aircraft now coming into service in increasing numbers. The work was due to be completed in 1961.

LANDINGS IN FOG

Another London Airport problem to be discussed was the development of an effective method of fog dispersal. Mr. Duncan Sandys said that considerable technical difficulties had arisen in this connection but he hoped soon to be in a position to decide whether it would be commercially feasible to establish a fog dispersal system.

He told Mr. G. R. Strauss (Labour) that it was not easy to contend with nature in this matter. He had been to the experimental station in Norfolk quite recently and could assure the House that everything was being pressed forward as much as possible. There had been quite a number of snags. As for the cost, it would be for the airlines concerned to decide whether they considered a system worthwhile. The best estimate which he had received was that the installation of a system of this kind on one runway would cost between £500,000 and £1 million, and that the cost of the fuel to be consumed would amount to about £250 for each landing.

Mr. A. Woodburn (Labour) inquired about the progress being made with the blind landing of aircraft, which would provide an alternative to FIDO. Mr. Sandys agreed that this was an important point. In considering whether a fog-dispersal system was feasible economically, it had to be borne in mind how many years it would be before airliners would be fitted with blind landing instruments which would make any fog dispersal system unnecessary. It would not be so many years.

EXPORTING CARS TO EUROPE

Motor car imports from the United Kingdom are not at present restricted in Austria, Denmark, Germany and Portugal. In addition, according to information supplied by Mr. F. J. Erroll, Minister of State to the Board of Trade, imports of cars of over 3,000 c.c. engine capacity into France, and of most completely-knocked-down cars into Benelux countries, were not restricted.

There were quotas for imports of British motor cars into Italy, Sweden, Switzerland and France. The values of these quotas, which were confidential, were negotiated between the United Kingdom and the country concerned. In practice, he told Mr. Donald Chapman (Labour), imports of United Kingdom cars into Sweden and Switzerland were not restricted, as licences were issued freely. In the case of the quotas of Norway and the Benelux countries, importers there could use their licences to buy motor cars where they chose and Britain's share of these countries' quotas depended upon how competitive our manufacturers were.

SPEEDING UP PATENTS

From time to time, attention is drawn to the length of time which elapses between the presentation of a patent application and the granting of a patent. Last week, Mr. Dudley Smith (Conservative) raised a number of points on this subject and urged the President of the Board of Trade to take steps to reduce the periods between the various stages.

He was informed by Mr. Reginald Maudling that the period which currently passed between the ascertainment that a patent application was in order for acceptance and its acceptance was approximately seven weeks. A further period of about 17 weeks passed between the acceptance of an application and the publication of the printed specification. These periods were dependent upon the time taken to make printing blocks and print the specifications. Steps were being taken to increase the rate of printing and an improvement was expected. The time between the expiry of the opposition period, when the patent application was unopposed, and the granting of the patent was three weeks. This period had remained unchanged for many years.

Fumes from Diesel Engine Exhausts

Research into the effect of diesel exhaust fumes on health continues to actively engage the attention of the Medical Research Council, according to an answer given by Mr. Derek Walker-Smith, the Minister of Health, to Mr. R. W. Sorensen (Labour). He said that these investigations had so far demonstrated no immediate or long-term deleterious effects from this source. The Minister of Transport was in consultation with the Department of Scientific and Industrial Research on the measurement and mitigation of this nuisance.

British Ships Building Abroad

Information was sought by Mr. Stan Awbery (Labour) regarding the tonnage of oil tankers and dry-cargo vessels now being built overseas which would fly the British flag when put into commission. He was told by Mr. John Hay, Joint Parliamentary Secretary to the Ministry of Transport, that his department had no official information, but it was understood that 16 oil tankers totalling 293,000 tons gross, and 15 other vessels totalling 70,000 tons gross, were under construction abroad for British shipowners. They were being built in Belgium, France, Germany, Italy, Japan, the Netherlands and Sweden.

Foreign Ships Ordered in Britain

Orders recently placed in this country by foreign shipowners have been decidedly disappointing. Mr. Simon Wingfield Digby (Conservative) questioned the Minister of Transport about this aspect and was informed by Mr. Ernest Marples that foreign orders placed with shipyards in the United Kingdom this year up to the end of October amounted to some 9,000 tons gross. In addition, orders for ships had been received from various Commonwealth owners. Up to the end of September, these orders amounted to some 14,000 tons gross. Orders placed abroad by British owners up to the end of September were understood to total about 197,000 tons gross.

German Nuclear Ship Propulsion

The " rapid progress " being made by Western Germany in the field of nuclear marine propulsion was another matter referred to by Mr. Stan Awbery. He wanted the Minister of Transport to say whether he was satisfied that sufficient funds were being made available for United Kingdom experiments. Mr. Ernest Marples said that there was no lack of effort in this country on the part of all concerned with the development of this form of propulsion. He was now considering how Britain could best make further progress. He had read the recent reports of German plans, but had no reason to believe that they were further ahead than Britain.

Dartford-Purfleet Tunnel

Questions were put to the Minister of Transport by Mr. Norman Dodds (Labour-Cooperative) and Mr. Sydney Irving (Labour-Cooperative) regarding progress on the Dartford-Purfleet Tunnel. In reply, Mr. Ernest Marples said that work on the project, including the planning and construction of approach roads, was up to schedule and should be completed in 1962. The cost of the tunnel and its approach roads, to date, was about £7½ million, including contracts which had been let but not completed. The final cost was estimated at just over £11 million. He could not say at present what tolls were likely to be charged. The Tunnel Committee's proposals had to be submitted to him and advertised. If necessary, there would be a public enquiry.

XUM

Single Syllabus for Science

No science teacher could cope with the whole of modern scientific knowledge. But he could, perhaps, convey an idea of the framework into which this knowledge fits.

Compared to the lifetime of the human race, the history of science extends only over a few weeks. In spite of the shortness of the span, within one or two scientific generations it has become impossible for any individual to assimilate all that is scientific knowledge. Science, in its totality, exists today in the libraries of the world and the minds of millions of people, scientists, philosophers, teachers, engineers, and the non-technical public at large: not in the mind of a single individual but in the aggregate knowledge of specialists.

Problems of secondary school science teaching arise from the educators' refusal to accept specialisation at an early age. It is realised that specialisation cannot be avoided altogether, but the educators have fought a spirited rearguard action to delay its onset until the student can be made at least partially responsible for his choice of speciality. The problem, from a pragmatic rather than educational point of view, is to prepare within a uniform educational system students who will later enlist in widely differing scientific specialities.

Science teaching at secondary school level has always been—of necessity—behind the times: it is always trying to catch up with new developments. When secondary schools first began to teach science, its development consisted mainly of extending the curriculum, of taking in more and more of the new discoveries that were being made at an exciting and perhaps alarming rate. The result was a stretching of the curriculum to its breaking point, and when further extension became impractical, the steady

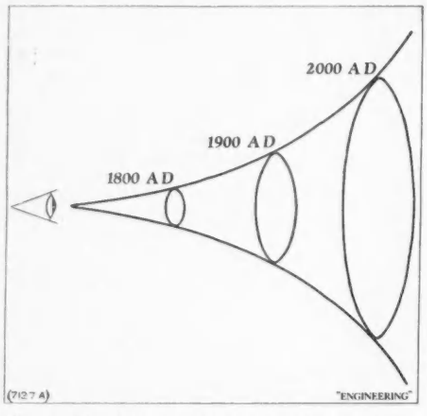


Fig. 1 The historic view of scientific knowledge.

encroachment of science subjects on the timetable of the liberal arts. The action was based on a world-view that regarded scientific knowledge as the cornucopia of Fig. 1. With every new invention or discovery, the bellmouth extends; and the process goes on as long as man's restless mind remains inquisitive.

Soon the resources of the timetable were exhausted and a consolidation of the science syllabus became inevitable. It was realised that the secondary school's function was not primarily to impart factual knowledge but to develop a scientific attitude that would find application in any field or speciality, whether in science, the liberal arts, or private life. The syllabus became a question of simple sums: so many hours of teaching are available, therefore so much material can be covered. The rest must be cut out. To close the gap between the scientific frontier and the level of secondary school teaching, material was discarded selectively from the overspilling cornucopia. The historic sequence of discoveries was disregarded and only material likely to stimulate the mind and illustrate scientific principles was retained.

LIMITS OF HUMAN KNOWLEDGE

Over the last fifty years, certain discoveries have been made which indicate that the cornucopia of infinitely expanding scientific knowledge is a mistaken view. The discoveries suggest that instead of extending infinitely from the point of viewing, scientific knowledge in fact extends in two directions from the viewer, and is infinite only in one. Fig. 2 attempts to illustrate diagrammatically the viewpoint in terms of physics and allied branches of engineering. The incorporation of other sub-species of science, although possible, would necessitate the use of more dimensions than are readily available on a piece of flat paper.

A person lacking any formal scientific education would be standing along the narrow black band of informal experience: he would be familiar with certain physical phenomena such as heat and light, some aspects of motion and elementary properties of structural materials. But other readily observable relationships such as the identity of wind and air would escape his attention and he would be unaware of any connection between his unrelated observations.

Looking outwards from the band of informal experience, the broad field of applied science stretches to infinity. The view is rather similar to that of Fig. 1, and equally frustrating for the non-specialist. But the view in the opposite direction would be much more encouraging, if only one could see far enough. Unfortunately the man of informal experience is not in a position to benefit from the view: he is only aware of a narrow footpath that may or may not go around in a circle. The middle of the circle, outside the view of his untrained eyes, is occupied by pure science, at the very centre of which lie the new discoveries mentioned before: the unified field theories; the basic equation of matter; the universal units of magnetism, mechanics and temperature; and the groping theories of cosmology. To do justice to the analogy it would be necessary to imagine that Fig. 2 is a plan view of a mountain with its peak still veiled in clouds. In some places the clouds are lifting or thinning out, in others the fog is as dense as ever and the hidden theories may never be discovered. The important point is that it is becoming increasingly clear that in the direction of pure science—towards the peak of the mountain—there is a limit to man's knowledge. The limit may take one of two forms: one day man may know all that there is to know, have answers to all outstanding questions; or else, there are things which he will never know. In either case there is an ultimate limit, and that limit is now in sight.

UNITY IN NATURAL PHENOMENA

The aim of the mountain-top analogy is to illustrate that there is an overlying unity in science. No matter what informal experience serves as the starting point of an investigation, the deeper one probes, the more widely applicable become the discoveries, the more artificial the divisions between branches of science. The differential equation describing the diffusion of neutrons in a moderator has the same form as the equation for the diffusion of heat; hydrogen is the building block both of the atomic theory of matter and the various theories of cosmology; the language of science is full of analogies which are not simply dodges around the inadequacy of words to describe abstractions, but are true reflections of the symmetry, parallelism and unity of natural phenomena.

If there is a limit to human knowledge in the direction of pure science, then there is a chance for education to catch up with the frontier of scientific discovery. Not in all the details, but in the essentials that indicate where the limits are, and how those ultimate efforts of investigation affect the things that are part of our informal experience. It is possible to catch up with the times because, close to the top, the area of a mountain is small.

The pattern of the secondary school science syllabus must then be questioned. Is it right to skirt the mountain with one foot firmly planted on informal experience and the other climbing only as far as it will reach? Educators are agreed that the best way to teach science is from a starting point of informal experience. But if such an approach prevents the syllabus from reaching a height where the unity of various branches of science becomes apparent, can one afford to carry on in view of the increasing scientific demand on future generations? Or will it be necessary to abandon experience for a more difficult abstract path?

The arguments in favour of teaching "comprehensive science" (of reaching the mountain-top) can be developed from both aspects of an

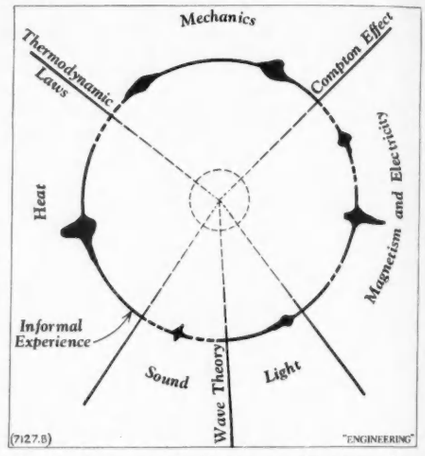


Fig. 2 Science extends in two directions from informal experience, but it is infinite in only one.

educational system: the "training" and the "educational".

From the point of view of training, no matter what speciality the student will follow, he will be better equipped if he grows up with a consciousness of the unity of science, the knowledge that his particular line of endeavour is not a separate compartment but part of a rational whole. The experience of a physicist, on whom the idea that his body, his clothes, his whole material surroundings were made of atoms did not dawn until his second undergraduate year is a result of teaching from informal experience: atoms cannot be experienced.

From the point of view of education the aim of the syllabus is to develop the scientific attitude, the deductive thought, the feeling for experiment. But without understanding the larger unity, without a grasp of "comprehensive science" the educational value will be limited.

The problems of teaching comprehensive science are considerable. It would require new books, a new syllabus, and a new generation of science masters. But, more important, some formidable pedagogic difficulties would have to be overcome before comprehensive science can be as much as attempted. The beauty of teaching from a basis of informal experience is that the student can be led by the master in an adventure of discovery. It is feared that teaching from "the top down" would destroy such an experience, replacing the element of discovery by didactic utterances of a remote master. Much of the pleasure of teaching, and most of the pleasure of learning, would be lost if teaching were to become didactic. A compromise must be sought in which the beauty of teaching and learning can be combined with the intellectual beauty and utility of an ordered world.

More Teachers, but not Enough

Implementation of the Crowther Report, with its outright appeal for a school leaving age of 16, would intensify the difficulties of getting enough science teachers. The schools are now just getting by as their numbers grow and the proportion of students studying science also rises. Once again this situation is described in detail, this time by the report *Scientific and Engineering Manpower in Great Britain* by the scientific manpower committee of the Advisory Council on Scientific Policy.

The Grammar schools, says the report, have just about been keeping up their standards of scientific teaching. The number of new graduate science teachers has not been enough to do more than that. From 1956 to 1959 the increase in science teachers was 10 per cent. By 1962 it will be necessary to have brought the number up by 16 per cent, after that date the position may well ease as the number of pupils falls, for a time, and the number of science graduates rises.

Back in 1956 the education authorities estimated that the schools, then employing 20,250 science teachers, would need 3,560 additional staff, an increase of 18 per cent. The sorry result was an increase of no more than 1,980, which is only ten per cent.

For the universities the position is not so bad. Some indeed feel that their relative position has improved over the past two years. In 1956 the number of scientists and engineers teaching in universities was 3,260, the estimated increase by 1959 was of 1,080 and the actual improvement was not far short—915.

In technical and teacher training colleges the number of science and engineering teachers employed rose from 4,530 (1956) to 5,560 (1959) and the actual increase was nine per cent behind the estimated needs.

Plainly the supply will have to be better than this if full advantage is one day to be taken of the universally accepted benefits that would spring from the Crowther committee's proposals, not only from the extra year at school but in more widespread part time education up to later years.

The rapidly changing equipment of industry means that the better understanding of mathematics that could be achieved with a general leaving age of 16 would greatly outweigh any loss in a year off some apprenticeships.

Over a broader field, the day is often said to be approaching when quite ordinary citizens will be challenged with greatly more leisure. What the individual does with it, to what extent his education has fitted him for other than the carrying out of commands, will help to shape the sort of society growing out of the latter half of the century.

Who Helps the Blind?

The greatest need of blind people is not the sympathy so easily given but work, in order that they may support themselves, and feel that they are self-supporting.

Outside London the Royal National Institute for the Blind has placed 4,500 of the sightless in work through its employment service since 1942. In London the LCC's blind welfare department understands there are 600 blind workers but many more jobs are needed, particularly for men.

Regional officers of the Ministry of Labour have recently been meeting on these problems. Blindness of all the disabilities is the most challenging to the employer who decides to provide a measure of opportunity for self-help.

In London, Gordon's, the gin makers have built up to nine the number of blind women who tackle a job which relies not on machines but deftness of touch. The women have to take off the paper covering on the white lead foil capsules that cover a gin bottle's metal cap and then place the capsule so that the holes in which its lever is held are in the correct position. This is essential if the sighted workers in the next stage of the movement are to work at top speed. This work leaves the blind women's disability on one side, employs their special ability, that feeling of touch often developed by the sightless, and enables them to earn—£6 17*s* 6*d* a week—what sighted women on comparable work do. Sighted workers help the women around the works and to and from transport.

For the sighted, but in other ways seriously disabled, the Queen Elizabeth's Training College for the Disabled has over the past 25 years trained 6,000 men and women to overcome the often bitter obstacles between them and useful life. Some 300 people a year pass through Queen Elizabeth's at Leatherhead Court, Surrey, going into the engineering industries, into gardening, and a variety of trades. For the College the greatest need is for money to keep up its work.

Better Foremen

Down in the London docks recent selection and training of foremen by the National Institute of Industrial Psychology has produced results that indicate the scheme is of much wider value than in the docks alone.

The firm concerned are Colonial and Eagle Wharves who employ men on unloading tea and other goods from barges, storing them in warehouses and despatching to factories. High standards of supervision are essential in this work and when Colonial and Eagle found themselves with three vacancies for foremen earlier in the year they called in NIIP.

The vacancies were advertised within the firm, a short list drawn up based on existing knowledge of the men and a group selection carried out. For the selection the NIIP's investigator arranged sessions at which applicants discussed the foremen's job and he devised practical work in which the group solved organisational problems with a model on the warehouse floor. After several days the manager and the investigator interviewed each applicant and selected three for the three vacancies, on the basis of observations during the group sessions and the interviews.

The investigator predicted that one of the men would be a very good foreman and the other two would be good. Inquiries made a short time ago confirmed these forecasts.

The "man from NIIP" was also asked to design a training scheme for the company to run. He began with the three new foremen and three of the younger of the foremen already employed. Working while training, the part-time course lasts for nine months and is intended to fit them to cope with any job at the wharf. Informal talks and discussions to explain the place of the wharf in transport and in bringing tea from plantation to packing factory were supplemented by visits to docks, lighterage companies, tea auctions and a packing factory. In practical training each man observed eight of the jobs done at the wharf and then analysed and discussed them with his superiors in order to make his knowledge systematic and thorough. The visits were highly appreciated by the firm and the foremen. The management of the packing factory were so impressed that they have arranged reciprocal visits for their own foremen. The training scheme is to be used for all newly appointed foremen.

Chemical Engineering at Cambridge

The department of chemical engineering at Cambridge University has officially moved into its new building, opened by Lord Godber, chairman of the Shell group of companies, on Wednesday, 9 December.

During his address, Lord Godber recalled that back in 1940 he and his company had become aware that the derth of chemical engineers in the country was such as to be a national weakness that would be disastrous if not corrected. At the war's end Shell offered Cambridge a gift of £435,000 to found a school of chemical engineering. The gift was accepted, and supplemented by an annual grant of £3,000 a year as the basis of the Shell Chemical Engineering Studies Fund.

The department initiated a new form of engineering education. The student entry was taken from men who had already completed part I of the natural science tripos in chemistry or of the mechanical science tripos. From the outset the department has provided a course suited to both groups, avoiding any attempt to mould them into a single pattern; the object has been to modify both and let them temper each other. As the Vice-Principal, Professor H. Butterfield, explained when introducing Lord Godber, stress in the department's teaching had always been on fundamentals, aimed at encouraging an original approach. He also acknowledged the importance of the private benefactor to the university in these days.

During their final year students undertake a modest research project rather than formal laboratory experiments and some information of genuine value has been obtained in this way. So far the Shell Fund has made grants to 54 students taking the chemical engineering tripos and two others have been supported by a parallel contribution from Esso. Post-graduate research has steadily increased and to date 21 students have submitted work for higher degrees.

The department began life in October, 1946, under the direction of Professor T. R. C. Fox and his original staff is now widely dispersed. In keeping with the Cambridge tradition, several lecturers from the new department have achieved chairs: K. G. Denbigh at Edinburgh, E. S. Sellers at Swansea, J. M. Kay at Imperial College, and now P. V. Danckwerts has returned to Cambridge from Imperial College to take over the Shell Professorship from Professor Fox, who has retired.

40 Hour Claim Again

Rather mysteriously one of the delegates at the special York meeting of the executives of the 40 unions in the Confederation of Shipbuilding and Engineering Unions exclaimed "Its in the bag" as he left the assembly hall.

In ten minutes almost 200 union leaders had unanimously agreed to back a second approach to the employers for substantial wage increases and a 40 hour week for 3,200,000 workers in the engineering industries and the shipyards.

So far the engineering employers have offered no money and one and a half hours off the week. The shipbuilders have also offered no money and the furthest they will go is to consider looking at the question of hours.

It may be that if anything at all is in the bag it is the union leaders willingness to put the hours reduction, itself a wage improver for some men, ahead of the increase in rates. The effect of a cut to 42 hours a week would be for many engineering firm employees a rise in the number of hours on overtime rates: from an average of three a week to an average of five. This would be almost without effect on a not so prosperous firm whose men were not working overtime, the booming concern with long order books and plenty of work for everybody would be better placed to carry the extra cost.

There might after a time be a situation in which workers actively sought jobs with the busier firms, a rewarding atmosphere for the firms concerned and a spur to those companies whose labour was preparing to swap leisure for overtime.

The next meeting with the employers will now be early in January.

Repeat Performance

CONTINUING last week's general appraisal of the American Nuclear Society (ANS) Winter Meeting, the following abstracts and notes represent a selection of the papers presented.

Liquid Fuel Systems

Interest in circulating fuel reactors has been drastically altered in the USA over the past year: work on these projects has been stopped or reduced to a low level. Among the three more promising types, namely, the aqueous homogeneous (AHR), the liquid metal fuelled reactor (LMFR), and the molten salt reactor (MSR), the MSR, which makes use of a solution of fissile material in molten salt, is thought to be the most promising as regards feasibility according to an assessment panel whose work was reported by J. E. Draley of Argonne. This is largely because of the difficulty of developing the slurry-fuel techniques necessary for the other two systems. Maintenance and complex auxiliary systems are seen as major problems and cost-factors in all plants of this class. All three are thought to be systems which could be developed into breeders on the thorium—uranium-233 cycle, requiring refuelling only with natural thorium. Each reactor type is considered to need ten years of concentrated development and over $100 million development expenditure.

Fuel Element Technology

If it is accepted that liquid fuelled systems are some way off, then an intensive effort to develop solid fuels capable of long irradiation lifetime and of high integrity becomes essential, and much effort is being devoted to these problems. The emphasis for the immediate future for water-cooled reactors is mainly upon uranium oxide, and uranium dioxide, clad in either Zircalloy or stainless steel. For more highly rated reactors work is in hand to develop metallic fuels in the form of molybdenum alloys of uranium ranging from 3 to 10 weight per cent molybdenum, clad in stainless steel for sodium cooling in the SGR (sodium graphite) or zircalloy in the FBR (fast breeder) or aluminium for the OCR (organic cooled reactor). For the organic cooled types much depends upon the degree of success achieved in fabricating reliable fuel elements using sintered aluminium powder (SAP) as the cladding material, present interest centering upon APM Alcoa N257 (extruded aluminium powder metal) which contains 7 per cent of aluminium oxide and which is said to have excellent creep-rupture characteristics at high temperature. Further ahead, there is interest in uranium and plutonium carbides and plutonium oxide as fuel materials, and cermets based on stainless steel and other materials, for instance plutonium carbide in a uranium alloy containing 15 per cent by weight molybdenum. However, by no means all the problems are solved in the uranium oxide elements, as yet so that there is much work to be done even for the immediate future. For example, C. N. Spolaris of General Electric presented a paper with some data on the performance of uranium oxide fuel in Zircalloy cans under conditions of can rupture based upon full-power irradiation experiments in the Vallecitos Boiling Water reactor. Possibly because of the evolution of very high temperature steam as a result of water penetrating intermittently to the very hot central region of the oxide fuel, or perhaps on account of some unexplained radiation effect, it appears that zirconium hydride and oxide is formed with consequent can swelling, although at 700° F zirconium is known to have good corrosion resistance in water. Cylindrical uranium oxide fuel pellets break up along a succession of circumferential and radial lines when subjected to reactor conditions, sometimes with the formation of a central void. There appears to be recrystallisation of the oxide near the centre with evidence of an increase in density, and the size of the central void has been shown to be a function of pellet-can clearance, the larger clearances leading to higher central temperatures and melting or near-melting conditions.

Problems Unsolved

The success of the OCR depends upon the successful development of sintered aluminium powder cladding with uranium oxide fuel, which looks very promising, and the practicability of operating with sub-cooled nucleate boiling at hot spots: this has yet to be demonstrated in connection with organic coolants under reactor conditions. The need for fuel cladding with good heat transfer is dictated by the poor heat transfer qualities of polyphenyls by comparison with water (a factor of about five), solved by filling the fuel cans. Of the high conductivity, low neutron absorption materials zirconium cannot be used because of the formation of radiolytic hydrogen under pile conditions and magnesium cannot be used because of the probability of some degree of water impurity in the coolant: some water must be expected to leak into the low pressure coolant from the high pressure water in the steam generator. Therefore some suitable alloy of aluminium seems to be an essential requirement for the organic systems. Table I shows a comparison of optimised pressurised water, boiling water and organic cooled 300 MW(e) reactors.

Stocktaking of Fuel Fabrication

As a guide to the direction in which fuel research should proceed, a task force evaluated the present needs of manufacturing. Regarding metallic fuel, the major limitation is still swelling, which occurs in any metallic fuel or alloy. The swelling mechanism is imperfectly understood and it is still not possible to predict the attainable burn-up. Uranium oxide fuels look promising but the operating limitations have not yet been fully determined. Performance of the fuel could be improved if thermal properties under irradiation, void formation, plasticity and diffusion of gaseous fission products were better understood. Although cold pressing and sintering of uranium oxide are now used, hot swaging, explosive forming and vibratory packing should be attempted to reduce costs. Uranium monocarbide is a promising high temperature fuel, but very little is known about its behaviour and only small quantities are available for experiments. For gas-cooled reactors, "fuelled" graphite is of interest, particularly if suitable coating materials are developed.

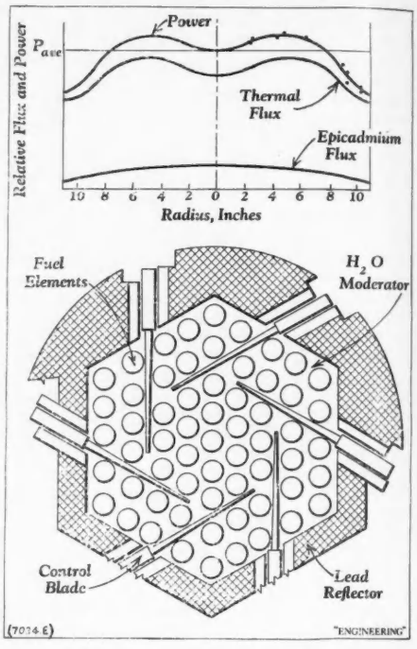
Turning to fuel testing, the task force found that current burn-up measurements are so inaccurate as to make any comparisons meaningless. An essential feature of fuel testing is controlled burn-up and temperature. The tendency is to test longer fuel elements, but present reactors have too steep flux gradients for uniform irradiation. Construction of one or more new test reactors is urged; these should have a flat thermal flux of about 10^{14}, which can be maintained throughout the test without variation. The current American effort on plutonium recycling is considered inadequate in view of the fuel's long term importance. For recycling, remote fuel element fabrication techniques should be developed and a pilot-scale production plant set into operation. Regarding fundamental research, the understanding of solid state mechanism of fuels is a necessity for their intelligent use. (Fuel Element Technology, B. R. Hayward, 1959, ANS Winter Meeting, paper 4-4.)

Superheating in Coupled Thermal-Fast Reactor

Good breeding and high steam-cycle temperature are incompatible in most reactor systems owing to the predominantly thermal nature of the neutron spectrum. Both advantages can be secured if a fast core is used in conjunction with a heavy water moderated thermal core in a coupled system. Steam is raised in an annular thermal core which surrounds a saturated-steam cooled fast core. The breeding ratio is a function of the relative amounts of power produced in the two cores, and is near unity if all the saturated steam used to cool the fast core is produced in the thermal core. If more saturated steam is raised in auxiliary boilers by degrading superheated steam from the fast core, the resulting breeding ratio is comparable to that attained in liquid-metal cooled systems. Behaviour of a coupled reactor is similar to thermal reactors, with neutron lifetimes more than an order of magnitude longer than in all-fast reactors. (Coupled Steam Superheater Concept, by J. P. Toppel and R. Avery, 1959 ANS Winter Meeting, paper 14-5.)

TABLE I.—*Optimised Generating Stations and Costs*

Reactor scheme	Core pressure, lb per sq. in	Pressure vessel		Coolant outlet, °F	Max. can temp., °F	Secondary steam		Overall thermal efficiency, per cent	Power costs (present)		Power costs (future)
		Diameter ft	Thickness, in			Pressure, lb per sq. in	Temp., °F		Authors'	USAEC	USAEC
PWR ..	2,000	10½	9	618	650	1,050	545	34·5	8·26 to 7·0	8·3 to 7·3	7·9
BWR ..	1,015	12¾	5·4	546	590	950	540	31·2	8·0 to 8·6	8·9 to 9·4	6·8
OCR ..	27	13½	1·5	675	850	640	650	29·6	7·31	8·3 to 8·8	7·1



Core of the US Army's transportable reactor is flattened by variable moderator-to-fuel ratio.

Flux Flattening for Gas-Turbine Cycles

Transportable nuclear generating plants are under development for the US Army. Aerojet-General are proposing a light-water moderated gas-cooled reactor in conjunction with a closed (Brayton) cycle gas turbine under the designation M-1. The nitrogen coolant circulates through 61 pressure tubes and leaves the reactor at a temperature of 1,200° F (649° C). The core is shown above. As the turbine cycle efficiency is sensitive to both coolant pressure drop and average gas temperature, it was important that uniform outlet temperature should be secured from every channel without gagging. Flux flattening was attempted by varying the core properties from a 63 per cent water volume fraction at the outer edge to 47 per cent at the centre. A critical assembly gave the flux distribution shown above, with a peak to average ratio of fuel channel power of 1·11.

Sodium Graphite Evaluation

Present knowledge of the behaviour of a sodium-graphite system permits performance prediction of a reactor giving steam at 850 to 900° F. The choice of moderator does not materially affect the problems associated with the use of sodium, and experience with sodium-cooled fast breeders and heavy-water moderated reactors are applicable. The limits to the maximum steam-cycle temperature are imposed by carburisation and severe thermal stressing. Materials suitable for a sodium-graphite system include type 304 and 405 stainless steels, chromium-molybdenum steels, and various alloys of zirconium, including Zircaloy. Beryllium is not fully satisfactory. The graphite moderator, although ideally suited for high-temperature operation, must be canned to prevent absorption of sodium. Canning may be stainless steel or zirconium, but both materials present some unsolved problems. In general, the sodium-uranium-graphite reactor may be considered to be stable, necessarily big, and to have poor conversion characteristics. (Sodium-Graphite Power Reactors, Charles Bullinger, 1959, ANS Winter Meeting, paper 4-1.)

Exit Heavy Water with Sodium Cooling

Use of heavy-water as a moderator permits sodium cooling in a natural uranium reactor. But the presence of sodium in sufficient quantities to ensure adequate cooling makes criticality marginal, and not enough is known of the lattice to complete a design

with confidence. Fuel assemblies at the present stage of development cannot be expected to survive to high rates of burn-up in a high-temperature sodium coolant flowing at scouring velocities. In addition, the reaction of sodium with heavy water must be considered a credible accident, which puts the concept at a disadvantage relative to other combinations of materials. Even on the conventional side of the plant, a sodium-steam heat exchanger presents some difficult problems. As a result, a sodium-graphite reactor cannot be built with present knowledge, and full development would be costly. The expected generating costs, even if all problems are satisfactorily solved, would not be competitive with reactors which are well tried today. (Sodium Heavy Water Reactor Task Force Evaluation, E. D. Jordan, 1959, ANS Winter Meeting, paper 4-3.)

Beryllium Reflector for the Belgian BR-2 Reactor

Beryllium reflector is used in the 50 MW(t) test reactor BR-2. The light-water cooled and moderated core is twisted into a hyperboloid (basket weave) so that fuel elements at the centre are on a closer pitch than at top and bottom. Reflector manufacture was complicated by the unusual core shape, and required use of rounds, hexagons and partial sections of hexagons complicated by skew distortions. Delivered cost of the reflector was over $200 per lb, but simpler shapes with a larger production run could be produced for about $100 per lb. The raw material was derived from beryllium fluoride by magnesium reduction, which was then cast into ingots. The ingots were chipped and powdered to 200 mesh, and the powder mixed with beryllium recycled from other manufacturing operations. Hot pressing of the powder gave substantially 100 per cent theoretical density. Typical ultimate tensile strength was 52,000 lb per sq. in, with a yield strength of 42,000 lb per sq. in. The average elongation was 2·5 per cent. (Fabrication of Beryllium Reflector Parts for the Centre d'Etudes de l'Energie Nucleaire—BR-2 Reactor, C. M. Ladd and J. D. Albrecht, 1959 ANS Winter Meeting, paper 6-8.)

Notes and News

Soviet Prediction of New Radiation Verified

Emission of a weak radiation following entry of a charged particle into media possessing changed optical properties was predicted by Askarian, Klepikov and Garibian. The radiation arises from the collapse of the force-field existing between the approaching particle and a particle of opposite charge in the media. The two form a dipole, and collapse of the dipole moment causes emission of the radiation. The phenomenon has been called transition radiation and two Harwell scientists, P. Goldsmith and J. V. Jelley, have now experimentally verified its existence by bombarding thin metal foils with 5 MeV electrons. The optical boundary investigated was between vacuum and metal, although the theoretical prediction indicated that radiation would be emitted at any optical discontinuity. Owing to the weakness of the radiation it is not a suitable property for the detection of single particles, but a thin metal foil placed in an intense particle beam might give rise to sufficient radiation to permit monitoring the beam flux. (*The Philosophical Magazine*, vol. 4, No. 43.)

Fast Pinch Injector

At the Geneva Conference last year, the Soviet physicist Alikhanov suggested that the fast pinch system could never become a practical source of thermonuclear power since the energy concentration during the period of plasma constriction would be of explosive power. Now, however, it is believed—and work at the Atomic Weapons Research Establishment appears to confirm it—that the fast-pinch system may serve as the plasma-heating element of a more complex system in which energy release would extend over a longer period, possibly in a stellarator or mirror type of device. The fields for the two systems would probably be set up in the same region and might overlap to some extent in time. The combined device would thus correspond broadly with the DCX machine, the fast pinch section being equivalent to the ion injector, though not suffering from the losses to which the injector is understood to be subject.

Safer Casting of Zirconium

Violent explosions have been reported from America when casting zirconium and similar reactive materials into certain water-cooled moulds. The US Bureau of Mines reports that reduction of the explosion risk can be achieved by using air-cooled moulds. These can be designed to perform as efficiently as the standard water-jacketed types. By using fins, air cooling can be 35 per cent more effective than water cooling. Although one air-cooled mould burned through during testing and the molten metal came in contact with air, no explosion occurred. ("Air-Cooled Crucible for Cold Mould Arc Melting," US Bureau of Mines publication 15443.)

Safe Accident at Shippingport

Operating Shippingport has proved to be not much different from operating any other power station. In manual control the operator's only regular action is periodic addition of make-up water to the reactor coolant system, and the movement of control rods to maintain the system temperature. Under automatic control, only make-up water has to be attended to. Reliability of the control system was proved when the turbine throttle valves were accidentally tripped during 60 MW(e) operation of the plant. The subsequent pressure and temperature transient, which lasted about 10 minutes, was followed by oscillation-free subsidence to a new equilibrium level without any movement of the control rods. A similar condition would have required extensive corrections in a conventional plant.

Heat Exchanger Tubing for Trawsfynydd

International Combustion, who fabricate the heat exchangers for the Trawsfynydd power station, have placed a contract for the supply of 200 miles of helically finned Tru-wel heat exchanger tubing with Tube Products Limited.

Plessey Burst Slug Gear for AGR

Detection gear for burst fuel elements will be supplied for the Windscale advanced gas-cooled reactor by Plessey Nucleonics. The equipment will be similar to existing installation at Calder Hall and Chapel Cross. Plessey gear has been selected for fourteen reactor installations including Bradwell, Hinkley Point and Trawsfynydd of the CEGB, Dounreay's DMTR, Harwell's Dido and Pluto, the WTR in Canada, and reactors at Latina, Karlsruhe, Wurenlingen and Marcoule in addition to the three stations mentioned above.

Control Rod Lubricants

Lubricants for mechanical reactor components are required to perform satisfactorily after irradiation to 3 million rads. It is estimated that the lubricant of the Calder Hall control rod bearings—Rocol Molytone—has received irradiation up to 7 million rads without damage.

Programme of Calder Operations School

In 1960 the Calder Operations School is planning to hold three five-week sessions, scheduled to coincide with the curriculum of the Harwell Reactor School. The dates of the courses will be 4 January to 5 February; 2 May to 3 June; and 22 August to 23 September. Students must be sponsored by the atomic energy authorities of their home country; hold engineering or physics degrees, and have attended at least 6 weeks of the Harwell Reactor School or some equivalent. The Harwell and Calder schools may be attended concurrently.

Reference Book on Uranium and Thorium Alloys

Binary and tertiary alloys of uranium and thorium are treated in alphabetical order in the reference book *Constitutional Diagrams of Uranium and Thorium Alloys*, by Frank Rough and Arthur A. Bauer, of Battelle Memorial Institute, Columbus, Ohio, published by Addison-Wesley of Reading, Massachusetts.

Studvik Research Centre Nearing Completion

Construction of the Swedish equivalent to Harwell at Studvik, south of Stockholm, is sufficiently advanced for some of the laboratories to start operating. Studvik will have three reactors, the zero power RO, and R2-0, and the low power R2. With the exception of the latter, construction of the reactors is complete. R2 is now a year behind schedule owing to difficulties with the welding of aluminium components, it is reported. About 200 scientists are already at work and the number is expected to rise quickly to 400. When the centre is fully developed, the scientific staff will total 1,000.

Symptom of the Times: Dutch Cancel Nuclear Station

In 1957 the Dutch Government published a memorandum on nuclear power. The memorandum proposed the building by 1975 of a number of nuclear power stations of sufficient capacity to take up about half the country's growing demand for electricity. The first plant at Geertruidenberg was to have a capacity of 150 MW, and it was expected that this power station would be complete by 1962. After 1962 it was proposed to spend over £600 million on atomic reactors and another £300 million on expanding distribution facilities. The Geertruidenberg plant was to have been built for a consortium of electricity producers, and work was about to begin. Now it has been announced that the scheme is to be abandoned because of the high nuclear generating costs. The decision to drop the Geertruidenberg project is of a piece with the recent fiasco of the contracts to be awarded under the US-Euratom Agreement, for which only one project was submitted. The key trouble is lack of balance between the price of coal and that of uranium. Euratom has refused to stockpile uranium because lower prices are virtually certain when the present purchasing agreements come to an end in 1962. All this means that with abundant coal stocks West European countries have decided to wait and see before committing themselves to nuclear power station building. The Dutch in this case are following their neighbours.

Uranium Prices

As a result of uranium over-production, the world price of the metal is expected to fall from the current $12 per lb to below $8 per lb in the middle 1960s, while no comparable reductions are expected in the cost of domestic coal or imported oil. The effect will be a reduction in nuclear generating costs up to 10 per cent according to Sir John Cockcroft, speaking to the International Atomic Energy Agency at Vienna.

New Flocculating Agent

A high bulk-density flocculant with a molecular weight of the order of several million has been developed by Cyanamid International as a filtration and settling aid for solid-liquid separation. In trials at a Canadian counter-current decantation plant for acid-leached uranium ore the new agent, Superfloc 16, gave the same performance as competitive products when used in smaller concentration. When applied in the same dosage as existing flocculating agents, Superfloc 16 improved underflow density by 6 to 7 per cent in a Colorado counter-current decantation plant. In addition to uranium mining, the chemical may be used to treat effluents, water, suspensions of sewage, and industrial and chemical wastes.

Man Sized Reactor

Designed to produce 3 kW(e) to power satellite instruments, Snap-2, an enriched uranium power reactor developed by Atomics International, has now accumulated several days of operating time. The reactor weighs about 220 lb without shielding, and occupies less than 1 cu. ft.

Atomic Energy Lectures for Schoolchildren

Six lectures adapted to an audience in the 10 to 17 age-group will be given on the release and use of atomic energy by Dr. T. E. Allibone, director of the AEI Aldermaston Court research laboratory. Starting with the atomic theory of matter and the Rutherford-Bohr model, a discussion of nuclear disintegrations and radioactive emission phenomena leads to the structure of the nucleus; the fission process, power generation, and the use of radioactive isotope tracers form the subject of the next three lectures; in the last lecture the status of thermonuclear research is reviewed. The lectures start on 29 December at the Royal Institution.

More French Shipbuilders Look for Nuclear Business

Four French Mediterranean shipyards have joined two engineering firms to form Sud-Atome, a new consortium for the development of nuclear energy, ship propulsion in particular. Previously, two Atlantic shipyards took part in the construction of the Saclay reactor EL-3, and a third shipyard, Chantier Navales de la Pallice, was reported seeking diversification in the nuclear energy business. (Atomic Review 18 Sept., 1959.)

Rear Admiral Nuclear Propulsion

Captain R. S. Hawkins, with acting rank of rear admiral, will succeed Rear Admiral G. A. M. Wilson, C.B., at the Admiralty as deputy director of marine engineering (nuclear propulsion).

Licence Suspension

A California radiographic firm's licence to use active isotopes has been suspended by the USAEC. The commission charged that the firm, X-Ray Engineering, did not maintain "calibrated and operable" radiation survey instruments at the sites where radiographic exposures were made using isotopes.

GE Test Reactor to Resume Operation

The operating licence of the 30 kW GE materials testing reactor is to be amended by the US Atomic Energy Commission, following difficulties experienced with fuel element support, control rod calibration and biological shielding. It is now proposed to resume operation at a reduced power level.

Men, Machines and the Antarctic Cold

The benefit of large scale investment in Antarctica is extensive experience with the behaviour of men and machines exposed to the hazards of extreme cold.

Latest estimates put world ice stocks at 4½ million cubic miles. About 90 per cent of this is held by Antarctica. The continent's 5 million square miles (1½ times the area of Europe) support ice that in some parts reaches a thickness of 14,000 ft. Not surprisingly, animals cannot survive, except near the sea. Over the year, the inland area does not have one month in which the mean temperature rises above fresh water freezing point. During winter, 100 knot winds are far from unusual, and temperatures reach −100° F. Under such conditions, exposed objects are rapidly cooled.

The ice forms a large dome that slopes from about 10,000 ft at the Pole down to 100 ft cliffs at the sea. Cold air flows from the dome into the moist warm sea air, resulting in extraordinary rates of change of temperature and wind.

Land surface and coastline contours are largely unknown. As was intended, the International Geophysical Year (IGY) led to a greater knowledge of Antarctica and the results obtained are still being worked out. Nor has research stopped: several countries are continuing their programmes.

Engineering skill has done much to assist the polar scientist in recent years—providing equipment, transportation, and improved living quarters. In return much has been learnt about the operation of equipment under Antarctic conditions, the materials and designs that can hope to be successful there, and the capability of the human operator under severe weather conditions. One fact emerging from the Trans-Antarctic Expedition, for example, was that whereas dog drivers were able to get about seven hours sleep, engineers got 5¾ hours. At present not many engineers are going to worry about this because large scale engineering projects cannot be expected in Antarctica until valuable mineral deposits are found there, or until political events conspire to make constructional projects imperative.

STRATEGY AND RESEARCH

Nevertheless, something like £500 million, the cost of 15 London-Birmingham motorways, has been spent on Antarctic research during the IGY. If spending on this scale continues, then the continent is going to provide an interesting parallel to other underdeveloped areas of the world—the Brazilian jungle and the Australian bush, for example. From the industrial point of view investment on this scale in the southern polar region is difficult to justify. The difference clearly arises because the expenditure is international, and because of the strategic and scientific importance of Antarctica. If these considerations continue to influence the rate of spending—and there is every indication that they will—then further developments in polar engineering can be expected soon. Nuclear power stations and the Hovercraft may find application there.

The Antarctic continent has considerable strategic importance. During the Second World War, German raiders had bases there, harrying merchant shipping and whaling fleets. An atomic war would probably put the Panama and Suez canals out of action and the holder of Antarctica would then control shipping passing around the capes. It would form a dangerous aircraft and submarine base.

International disputes about sovereignty of Antarctic territory have existed for some time. A six week conference between 12 nations helped to clarify and regulate the situation. Countries that had participated in the IGY polar operations took part in the conference: USA, UK, USSR, France, Argentina, Australia, Chile, Norway, South Africa, Japan, New Zealand and Belgium. Agreement on all articles of a Treaty was announced this month.

The Treaty, which will require ratification by the Governments concerned, provides for territorial claims to be frozen for 30 years and for a system of mutual inspection to ensure that the area is used for peaceful purposes only. A high degree of scientific cooperation is also envisaged.

The Antarctic represents a 5 million square mile gap in many fields of study: meteorology, oceanography, geodesy, geomagnetism, seismology, ionospheric physics, glaciology. Studies of this type not only reveal new facts about a hitherto little explored area, but also throw light on the part played by the south polar region on the physics of the world. And the region plays a very important part. The large accumulation of ice forms a natural refrigerator that controls climates and oceans; and ionospheric and magnetic conditions at the Pole are a key to the behaviour of the ionosphere as a whole.

SOUTH BY SEA AND AIR

British, American and Soviet scientists, among others, are active in Antarctica. A convoy left the Soviet station of Komsomolskaya in November on an expedition to cross the southern magnetic and geographic poles. American stations—Byrd Station, Hallet Station, Scott Base, Pole Station, NAF McMurdo, and Wilkes Station—are carrying out measurements in all fields of study mentioned above. On the mainland of Graham Land and on the surrounding islands there are seven British bases—including the Halley Bay base previously used by the Royal Society—operated by the staff of the Falkland Islands Dependencies. Their programme, which has been in operation for the past 15 years, occupies 80 to 90 men. Studies carried out include those mentioned above and also a tellurometer survey, studies in ice navigation, building research, and physiological investigations.

The MS Kista Dan left Southampton this month with the year's third party of scientists bound for the Graham Land area. In January the ship will call at Monte Video to pick up Sir Vivian Fuchs and also two aircraft—an Otter and a Beaver. The party will then go on to open up the base at Stonington Island again: it was closed last March owing to severe icing conditions. The research ship John Biscoe will play a large part in this operation, assisted by the Kista Dan.

Kista Dan provides a good example of a ship designed for polar operation. Built at the Aalborg Yard, Denmark, in 1952, she is owned by J. Lauritzen Lines and used as a combined cargo and passenger vessel. She has a total deadweight capacity of about 1,200 tons when carrying 12 passengers. One of her main features is the ice-breaking stem. Shell plating at the bow is about 1 in thick and frame spacing is reduced to 12 in—half what is normal for this size of ship—all frames having scantlings corresponding to normal frame distance. As a result, local strength in the bow is 16 times greater than the strength of a similar sized ship constructed to the requirements of normal classification.

One of the vessel's most precious parts when navigating in ice is the propeller. On the Kista Dan three broad fins of heavy construction, projecting horizontally from both sides of the underwater hull, force ice away from the propeller. To save the rudder and rudderstock from damage when the ship goes astern in ice-filled waters an ice knife is fitted aft. The vessel has a variable-pitch propeller that allows the pressure of the stem against ice to be increased about 30 per cent beyond that possible with a fixed-blade propeller. Manoeuvring can be carried out from the enclosed crow's-nest on the foremast, a vantage point from which the submerged parts of icebergs can be detected. Two similar ships to the Kista Dan have been added to the Lauritzen fleet—the Magga Dan, shown in Fig. 1, and the Thala Dan. All three have been used extensively in the Antarctic.

Air transport to Antarctica has developed greatly in recent years. A USAF group attached to the US Navy Task Force 43 has been flying Globemaster transports regularly from Harewood Field in New Zealand to an ice runway in McMurdo Sound. The same aircraft have been used in the interior for dropping supplies from the air. Anything from crates of eggs to massive D-4 crawler tractors have been dropped successfully.

A Pan-American Stratocruiser, complete with stewardesses, has landed at McMurdo. The runway extends over bay ice several feet thick, and pine tree branches mark out the limits. Specially shipped by air, the branches are just stuck into the snow and offer no resistance to an aircraft if an overshoot occurs.

The Royal Australian Air Force are interested in Wilkes Station. A survey is being made with the construction of an all-weather airfield in mind. The station is only 2,100 miles from Hobart and RAAF C130 Hercules aircraft with a 20 ton payload could reach it from Australia in about eight hours. Civil airlines are interested too. Qantas have indicated their ability and willingness to fly there with Super Constellations or Boeing 707 aircraft.

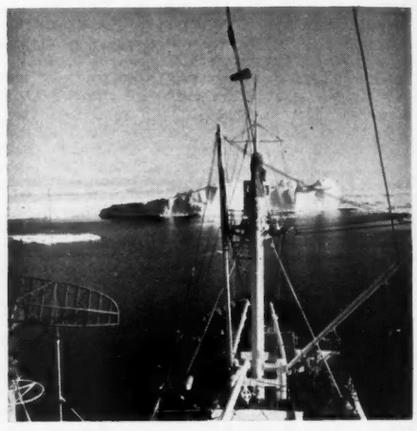


Fig. 1 The Magga Dan, like the Kista Dan, can be manoeuvred by controls in the foremast crow's nest, from where underwater parts of icebergs can be seen.

Antarctic great-circle routes would shorten travel between countries in the Southern hemisphere considerably. Sydney to Buenos Aires by way of a base near the Bellingshausen Sea would be about 6,400 miles—half the length of the present round-about route via San Francisco.

United States Navy pilots have flown some 23,000 miles from McMurdo Sound over the South Pole, the South Magnetic Pole and the Pole of Inaccessibility, trimetrogon cameras in their planes charting a million square miles of territory.

Dr. Lloyd Berkner, chief science adviser to the US State Department, has declared that "The Antarctic is not nearly as inhospitable as you might suppose. One can live in relative comfort providing preparations are so complete that no accident occurs. But such an environment requires great ingenuity to exist until the land becomes more populous."

In 1957 some 200 men spent the long winter night there. During the IGY more than ten thousand others, including women (nearly all Russian) visited the continent. The various bases used are shown in Fig. 2. Living is expensive. One United States operation alone

cost $60 million, while restocking of the bases for a season cost about $10 million.

Dwellings used have included tents, vehicle packing cases, caravans, and various types of hut. One type of American hut is made up of heavy canvas and thick glass-fibre sections stretched over a light metal framework. The floor is plywood, very strong, and raised above the snow. Two oil stoves and circulating fans provide heat.

A British hut used as a weather station on opt of the ice cap, 300 miles inland, was of prefabricated construction built up of aluminium and wood. It consisted of aluminium portal frames supported at their 9 ft 6 in high apex by tubular props. Its floor, 16 ft square, was supported by a grill made of bolted H-sections. Cladding of roof and walls took the form of sandwich panels 7 ft 6 in long by 2 ft wide with aluminium sheet on the outside wall, plywood on the inner wall, and a filling of insulating materials. A form of stressed skin was used, stressed tie-wires running vertically through the panels. Guy ropes secured the hut against high winds.

Aspects of Antarctic living are revealed by the laconic side notes in status-of-programme reports issued by US stations each month. August, for example:

Byrd Station—" With the re-appearance of the sun, heavy equipment is being dug out and checked for the forthcoming season. With the assistance of some explosives, the remainder of the chemicals situated on a 10 ton sledge outside was broken loose, with complete recovery of all chemicals. . . ."

Pole Station—" On August 19th the Pole Station recorded a temperature of −108° F, establishing a record for the station. Camp inspection reveals additional timbers broken in the cache area. The metal beams around the main camp entrance have been bending and oil-drum columns were installed to prevent further deformation."

Hallet Station—" Fishing was attempted through the ice but, after 14 days of no results, the programme was temporarily suspended. August was the coldest month recorded for Hallet Station this year, with a low of −54° F and an average of −24° F. These temperatures broke both existing records. . . ."

Wilkes Station—" Daily tending of improvised traps during the month has resulted in a catch of over 200 fish. The 41-day-old ice is now 21 in thick. Final lecture of the season was given by Richard L. Penny on the life cycle of the Adelie penguin. . . ."

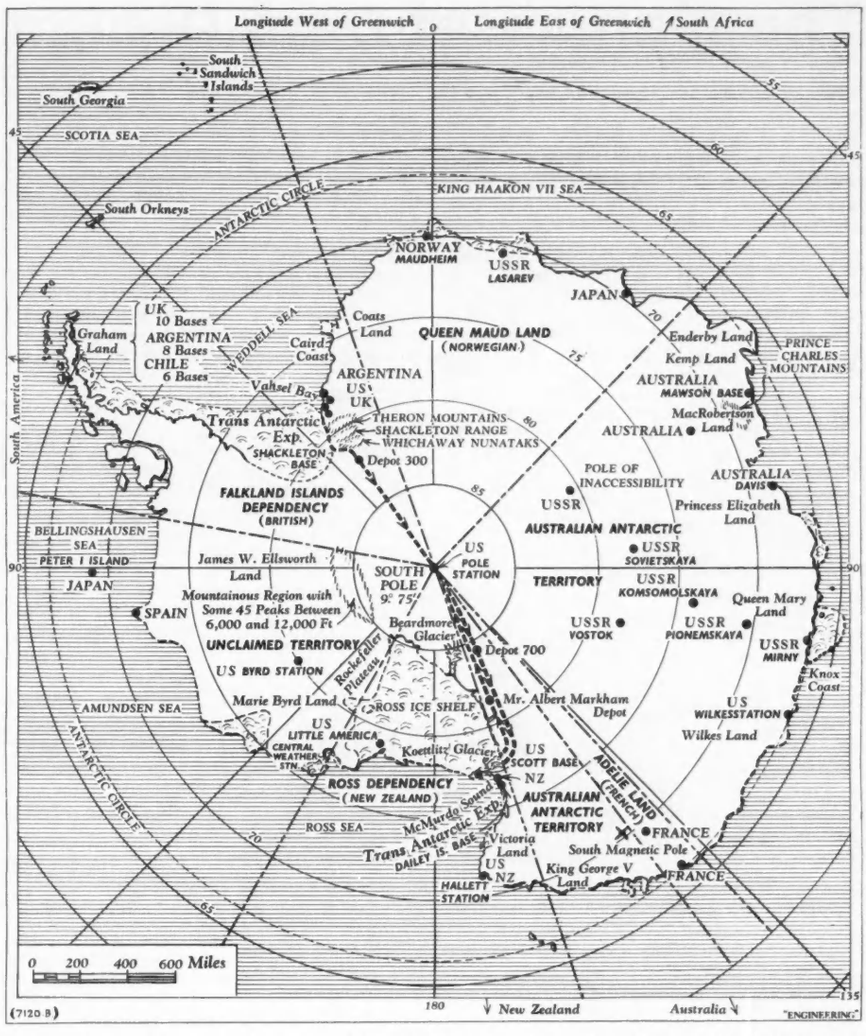


Fig. 2 Antarctic bases, and the route of the British Trans-Antarctic Expedition and the New Zealand support party.

CRAWLERS OVERLAND

Development of over-snow transport in Antarctica has been slow. A detailed account of it is given in a paper " Performance of Vehicles under Trans-Antarctic Conditions," by D. L. Pratt, transport and engineer officer on the Trans-Antarctic Expedition (Institution of Mechanical Engineers paper, April, 1959). Not until 1947 was the continent penetrated to any great distance by vehicles: two 16 ton LVT " Amphibians " fitted with 3½ ft oak planks on their tracks to improve traction pulled 8½ ton sledges 250 miles before being recalled to base. In more recent years both American and Russian expeditions have experimented with even larger vehicles—diesel crawler tractors with tracks up to 6 ft wide for example. Some of the Russian tractors are large enough to contain a laboratory and living quarters. In general, the trend for inland travel has been to use light vehicles for reconnaissance and heavy vehicles for load carrying, backing these up with air support for supply and scouting.

In the Trans-Antarctic Expedition specially modified petrol-driven Sno-Cats formed the core of the convoy; they proved to have the best traction properties over snow. Data on temperature, snow hardness, and grain size gathered by the expedition will be of great value for the further development of tracked vehicles. One of the most exciting prospects for Antarctic transport is the use of large ground-effect vehicles such as the Hovercraft. These would move at comparatively high speeds when supported about 2 to 3 ft above the ground on a cushion of air. Development of faster and more comfortable travel in Antarctica is held back only by costs.

The problem of materials for polar use is also an economic one. Standard production materials can be expected to give trouble at low temperatures, but the problem is not new: high altitude aircraft, for example, often operate at − 75° F.

Low temperature operation can lead to brittle fracture of ferrous components. Improved design, use of materials with high notch-ductility, and normalising treatment can all contribute to better performance. Most of the face-centred cubic non-ferrous alloys should increase their strength and hardness and maintain their toughness at the temperatures likely to be encountered, while zinc and magnesium alloys with close-packed hexagonal structures are likely to be brittle. Traces of impurities such as antimony prevent the brittle transformation of tin in solder. As industrial solder contains such a trace, standard radiators were used on the TAE vehicles and no trouble from embrittlement was experienced. Elastomers harden and become brittle at low temperatures. Both specially compounded natural rubber and normally compounded natural rubber were used by the New Zealand expedition on Ferguson tractors. Silicon rubber cable was used for the wiring of the TAE vehicles.

As far as sledging is concerned, Mr. Pratt points out that friction on snow is complex and appears analogous to friction in gears. Drag coefficients for varying loads and temperatures were found to be asymptotic for speeds over 10 m.p.h., using Maudheim sledges. PTFE was found to have a lower friction coefficient than Bakelite.

Engineering problems in Antarctica are surmountable, but very expensive. The threat of monopoly by one power of valuable mineral deposits is likely to be enough to keep the major powers active in the area. But if minerals are found in great quantity—and as yet no economic way of penetrating the thick ice cap has been found, so that all assessment of mineral wealth is speculative—the cost of extraction will be enormous. The building of the Kitimat project for processing aluminium ore in British Columbia cost £200 million. A similar project on the Antarctic continent is likely to be twice as expensive. Compared with space research programmes such expenditure is quite small. But there are other under-developed areas that might produce a greater return for similar capital expenditure; for example, the mineral deposits valued at £170,000 per square mile that have been found in the Pacific.

Antarctic exploration and space travel are not so widely separated as might be imagined. The human problems of existing in restricted quarters for long periods under severe conditions are similar. And the problems of mechanised transport and its maintenance in inhospitable terrain and forbidding climatic conditions in Antarctica serve as a grim indication of the difficulties that await any man who should attempt to explore the surface of the Moon.

The Malpasset Dam Design

The dam at Malpasset was just one in the evolution of the thin-walled arch dam. Why it failed is a question that must be answered if the safety of all other similar dams is not to be suspect.

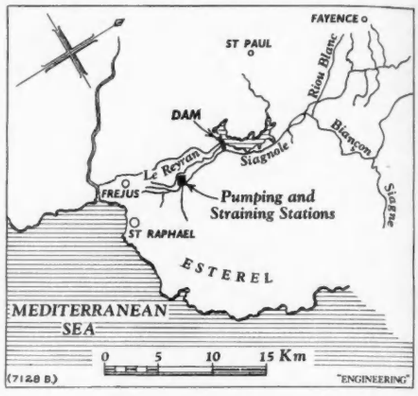
The Malpasset dam, which failed on Thursday, 3 December, causing great loss of life and immense damage, was a thin-walled arch dam typical of many others that have been built. The great arch dams of the United States, France, Italy, Portugal and Switzerland are among the boldest and most impressive structures in the world, often exceeding 300 ft and sometimes even 600 ft in height. Malpasset was small by these standards: only 197 ft high but, for a short while it was distinguished by having the smallest thickness to height ratio (0·11) of all the arch dams.

Why did Malpasset fail? The answer to this question may never be known, but it is essential to seek an explanation if similar or perhaps even greater disasters are to be avoided. An official technical inquiry is being held in Paris out of which may come a fundamental change in the approach to the design of arch dams—and their equipment.

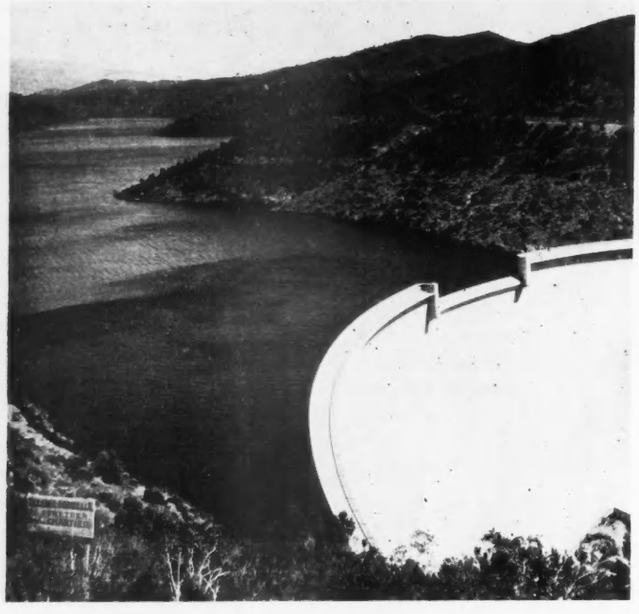
Arch dams are not only cheaper than other massive dams—the saving in material may be as much as 60 per cent—but they have always been regarded as inherently more safe than any other type. Gravity and buttressed dams rely on the shear strength of their foundations and on their mass to resist overturning. In arch dams the stresses are essentially compressive and the water load is converted into a thrust that acts on the abutments in direct compression. This leads to a high factor of safety. The methods of analysis are well established and have been consistently checked by models; many measurements have also been made on existing dams and, though relatively few results have been published, nothing has appeared to cast doubt on the design techniques that have been developed. So confident have some designers become of their methods that a number of dams have been built, particularly in Italy and Portugal, that are 600 ft or even 800 ft in height, though in these cases the designers have had to rely heavily on model analysis for it is doubtful if the sections chosen would have been amenable to mathematical treatment.

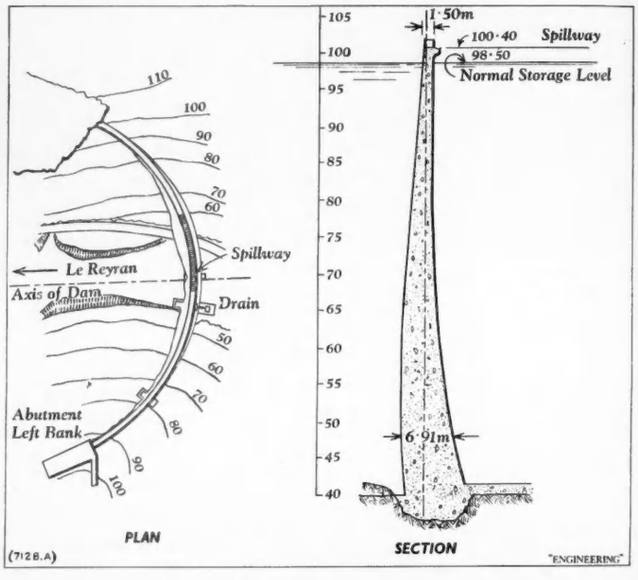
Malpasset was nothing like so extravagant as this. Indeed, so ordinary was it that only one article about it had been published in the technical Press and, apart from statistical data, nothing is to be found in the reference books. The one source of information is a paper given to the Large Dams Conference in Paris in 1955 and published in a supplement to *Traveaux* of May 1955 while the dam was still under construction.

The dam was built to collect the waters of the Rivers Reyran, Biançon and Siagnole and their tributaries and so permit the development of a new distribution network for drinking and irrigation water for the *cantons* of Fayence, Fréjus and Saint-Tropez. It may be of significance to note that the Siagnole, which runs close to the eastern edge of the reservoir, is a subterranean river that had been canalised. The Reyran was frequently dry for two months of the year.

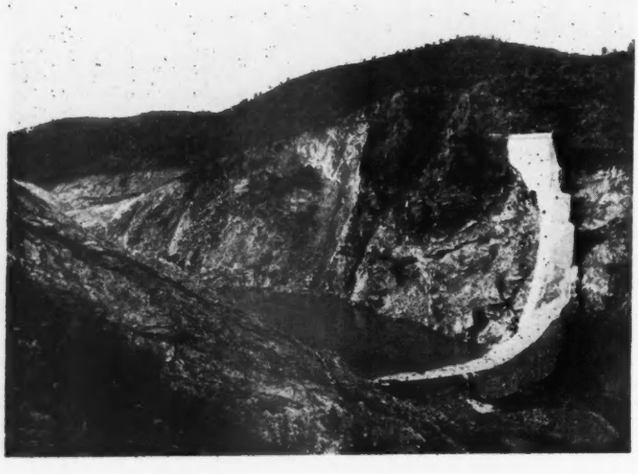


(*Right*) *Location of the dam.*





(*Above right*) *Plan, profile and principal dimensions of Malpasset.*



(*Above left*) *Malpasset as it was.*

(*Left*) *Malpasset as it will be remembered.*

Geological and hydrological studies were begun in 1945 and showed that a "most favourable site was to be found on the Reyran at a place known as Malpasset." The basin of the Reyran was described as being in a "synclinal carboniferous zone enclosed by the metamorphic horizons of the base Massif of the Esterel." The site was declared to be absolutely watertight and eminently suited to the construction of an economical type of structure such as a thin arch dam. At this point the Reyran flows at a level of 42·5 m above sea level.

The profile of the valley, as may be seen from two photographs on this page, takes the form of a trapeze, the valley being about 30 m wide at the base and some 180 m between the hill crests which are about 60 m higher than the river.

The dam was a thin arch having radii which varied with height both on the upstream and downstream sides; at the expense of a slight complication in the shuttering, this made for the most economical use of material. The angle

subtended at the crest was 135°—corresponding closely to the "ideal" angle of 133½° that is associated with a minimum volume for the section of an arch dam.

The main dimensions of the dam are as follows:

Depth of foundation below the bed of the river	6·5 m
Height above the river bed ..	60·0 m
Maximum thickness	6·91 m
Thickness at the crest	1·50 m
Upstream radius at the crest ..	105·0 m

The profile and plan are shown in the accompanying drawings.

The spillway, which was at 100·40 m, had a length of 29·68 m and was offset towards the right-hand bank. It was a free spillway designed to pass 180 cu. m per sec and to throw the overflow water clear of the foot of the dam. To minimise damage by the overflow, a strongly reinforced concrete pad, 0·50 m thick and having an average width of 30 m, was laid across the downstream side of the dam.

Outside the width of the spillway, the crest of the dam was levelled off at an elevation of 102·55 m by concrete blocks and guard rails. This crown construction formed a cornice that completed the architecture of the dam. It also allowed the designers to consider the top water level rising by as much as 0·5 m in time of exceptional flood, when the discharge over the spillway was expected to increase to 250 cu. m per sec.

On the right bank, the arch rested on a massive rocky peak. On the left bank, the arch was founded on a concrete abutment that was protected by a wing wall, this construction being thought necessary because of the "topography of the site." It was on this left bank that the dam failed completely, the concrete wall being apparently sucked clean away from the rock face. Reports from the site refer to very poor rock left exposed at this point by the collapse of the dam. The published paper makes no direct reference to this poor rock, which has been described by a correspondent who has been to the site as now exhibiting "a smooth shale-like surface so friable that it crumbles under foot." It would seem, however, that this relatively weak outcrop was known to be there and that was why the peculiar construction on the left bank was thought necessary. Nevertheless, it is almost inconceivable that overloading at this one point could have brought about collapse of three-quarters of the wall.

The mechanical equipment included a drainage arrangement and the intake works. The former consisted of a steel conduit 1·50 m in diameter passing radially through the bottom of the arch at a level of 45 m. It was protected by a reinforced concrete grille and could be closed on the upstream side by a sluice gate which was lifted by hooks and a rack and pinion winch. Downstream the sluice was controlled by a butterfly valve that opened automatically when the level in the reservoir reached 99·5 m. Reports suggest that the gate was kept shut until the level had reached at least that of the spillway.

The main intake was a steel conduit, 0·9 m in diameter, located at a level of 79·5 m at the quarter-point near to the left bank. It was protected by a fine metal grille and a cone-shaped guard valve which could be raised to the crest by a winch. The intake was controlled by an automatic shutter that enabled the flow to be regulated between 0 and 1,600 litres per sec; this shutter was situated some distance from the dam and was protected by a surge tank.

Construction of the dam began on 1 April, 1952. The Portland cement content of the concrete was kept constant at 300 kg per cu. m. of concrete (except for the abutment where it was reduced to 250 kg per m). The water/cement ratio was 0·55. The arch was built in 17 separate quoins, averaging 17·5 m in length, and poured in lifts of 1·5 m. Concreting of adjacent quoins was spaced out by about three lifts. All the contraction joints were provided with primary and secondary grouting runs, and were closed on the upstream side by copper strip and downstream by steel sheet. Cement grout was injected to close the joint between the rock and the concrete of the wall.

Malpasset was well designed and well built, there can be little doubt of that. But Malpasset failed. How and why, are vital questions that might well affect the safety of many other thin-walled arch dams.

Economy in House Construction

For house building today, the general cost of factory-made components is substantially higher than the costs of the traditional items replaced, and the saving in site labour resulting from their use are insufficient to off-set their higher material costs. Economy in house-building today can best be sought in the evolution of traditional processes rather than by the introduction of radically different principles of construction.

These are two of the principal findings of a study originally initiated by the Ministry of Works and given in Special Report No. 30, National Buildings Studies, *A Study of Alternative Methods of House Construction*, published for the Department of Industrial and Scientific Research by the Stationery Office (*7s 6d*).

The investigation covered 412 houses of three different basic types being built by five different contractors. Much of the difficulty of using pre-fabricated parts arose because they replaced only part of the corresponding traditional operation. This frequently meant that the number of operations, and the complexity of the process, was increased.

Though based on a limited study of small houses, the detail of the report is sufficient to warrent its thorough study by all those concerned with building, including the erection of blocks of flats, offices and other industrial premises.

Too much Compensation Water?

Arising out of the national water shortage earlier this year, Mr. Stanley Canvin, chief engineer and general manager of Glasgow's water department, suggests that water authorities should turn their minds to a policy of general reduction in the amounts of compensation water permitted.

Glasgow itself managed throughout the year without imposing any restrictions on the use of water. Nevertheless, the compensation reservoirs at Loch Vennachar and Loch Drunkie were virtually empty before it began to rain; so heavy was the rain then that it raised the level in Loch Katrine—the city's main reservoir—by 4 ft in ten days and 8 ft in the following six weeks. At one point the water in store for supply and compensation had fallen to 42 per cent of the maximum.

Within Glasgow's collecting area there has been a defficiency of rainfall of 13·25 in below the long-term average of 75·11 in for the first eleven months of the year.

Code of Practice for Prestressed Concrete

The first code of practice to deal with prestressed concrete, CP115, *The Structural Use of Prestressed Concrete in Buildings* (*8s 6d*) has been published by the British Standards Institution. Although limited to prestressed concrete in buildings the recommendations have a much wider range of application.

Permissible stresses in the steel and concrete, and values for calculating losses of prestress, are given for beams, slabs, columns for conditions arising during prestressing operations, during construction and under working loads. A method for calculating the ultimate strength of a member is recommended.

Guidance is also given on the use of secondary reinforcement and on the fire resistance of beams and slabs. Other recommendations relate to the design, use and maintenance of prestressing equipment; to the materials and methods of grouting cable cavities; and to the techniques of concreting, preparation of formwork and the handling of prestressing steel.

Mass Drilling on a Rock Face

Anchor bolt holes for the spillway face of the Thomaston dam, Connecticut, USA, are being drilled from the high-slung drilling rig shown in the photograph. Design of the rig is the combined effort of the contractors, Oneglia and Gervasini, Inc., and the Joy Manufacturing Company, Pittsburgh, Pennsylvania. The platform, 16 ft long and 7 ft wide, rides up and down a 30 ft tower that is suspended from a crane boom so providing mass drilling facilities for little set up and breakdown time.

Crane-mounted drilling rig.

Two Joy drifters are used to drill 14 ft holes at 4 ft centres at an average rate of 500 ft in each 8 hour working shift. The rig starts at the top of the cliff, where the first two holes are drilled, then the platform is lowered 4 ft and a second pair of holes is drilled. When that section is complete the crane travels sideways 5 ft, the platform is raised to the top and the process is repeated.

Good Appearance in Steel Road Bridges

Steel road bridges can be aesthetically pleasing and can exhibit the same sweeping lines as are seen in concrete.

This is forcibly demonstrated by the winning entries in the steel highway bridge design competition organised by the United States Steel Company. The results of this $44,000 competition were given briefly in these columns for 30 October (page 411). A booklet has been prepared illustrating the winning designs. The majority of the entries made use of composite action in the decking and continuity in the main girders. High strength steels gave many of the designs a light, clean appearance. Some of the bridges incorporated prestressing to reduce further the weight and dimensions of the superstructure. It was also noted that longer spans (the bridge had to cross a four-lane highway) were more economical because they eliminated some foundations and reduced erection costs. Elimination of a central pier also gave improved safety to the motorist.

Renault Production Increases

Two thousand two hundred vehicles per day. That is the latest production figure for Regie Renault, the sixth largest motor manufacturing firm in the world. In September, 1958, their daily production figure was 1,800 vehicles per day.

Undoubtedly France's first motor manufacturer, Regie Renault turn out a good deal more than the road vehicles for which they have become so well known. Its agricultural division makes about a hundred tractors per day, while the railway division builds tyre-equipped underground carriages, autorails, turbine locomotives and locotractors. In addition to all this, a special machine tool division builds machines for industry, both in France and abroad.

Not including the subsidiary firms, the various Renault commercial and industrial divisions employ some 63,000 people and cover almost 3,000 acres. Last Autumn a new factory, employing about 1,000 workers, was opened at Cleon, near Elbeuf, France.

In addition to continual expansion of their production plant, Renault have been steadily developing engineering and research departments. This year these departments were responsible for the development of the " Floride " and the recent 500 and 600 kg " Estafette " runabouts.

The studies of the engineering and development departments have been largely aimed at reducing the operating costs (by lowering fuel consumption) of vehicles, since this has been one of the main customer requirements in recent times. But, in addition to this work, they recently introduced the " aerostable " suspension technique, which is said to have " considerably increased comfort and road stability." This new softened suspension system (ENGNG, pp. 344-345, 16 Oct. 1959) has now been adopted on the Dauphine, Dauphine Gordini and Floride, at no extra cost.

Production increases, which have not ceased for the past 18 months, have enabled the Renault empire to increase its sales, particularly on the foreign markets. In fact they are now selling more than half their cars outside the Franc area.

Renault Floride coupé

Made in Japan

The phrase " made in Japan " used to be almost synonymous with " cheap and shoddy." But since the Second World War, Nipponese manufacturers, especially in the electronics business, have succeeded in living down that reputation. Now they have turned their attention to motor cars.

In the past six years Japanese motor vehicle output has gone up by some 350 per cent; but, even more important than the numbers, has been the tremendous improvement in quality. For the first time ever, Japanese cars are competing with those of Great Britain, Germany, France and even America. The production of passenger cars in Japan increased between 1954 and 1958 from 14,000 to 50,000. This year's total output of four wheeled motor vehicles is expected to approach 300,000.

Undoubtedly the main aim of most of the Japanese motor firms just now is to produce a popular baby car, or " people's car," which will have a vast sales potential in a country where there is only one car per 131 people.

Perhaps the best all-round model of this type is the Mitsubishi 500, which is already in production and will be on the market some time next spring. Made at the factories of the Mitsubishi Heavy Industries, this car is quite comparable to European cars in the baby class. It has a 493 c.c. air-cooled twin clyinder engine which develops 20 b.h.p. at 4,600 r.p.m. It seats four, is said to do 85 m.p.g. and to have a top speed of about 56 m.p.h. The wheelbase is 6 ft 9 in and the overall length is 10 ft 3½ in. It has a three speed gearbox with synchromesh on two. It is planned to produce 500 of these cars per month and it is expected that they will retail in Japan at less than £400.

Another fancied competitor in the Nipponese " people's car " race is the attractive little Suzulight TL. Made by Suzuki Motors it is of the estate car variety, designed to carry either four people, or two people and a 600 lb load. It has a 360 c.c. air-cooled two-cylinder two-stroke engine developing 21 b.h.p. at 5,500 r.p.m. It is said to have a top speed of 50 m.p.h. Wheelbase and track are 6 ft 9½ in and 3 ft 7 in respectively. Overall length is 9 ft 10 in.

In addition to the popular baby cars, Japanese firms are now turning out models such as the Datsun Bluebird, made by Nissan Motors. This has a 1·2 litre engine giving 43 b.h.p. at 4,800 r.p.m. It is said to have a top speed of 72 m.p.h. The overall length is 12 ft 8 in.

BMW to Build Mercedes Cars?

Some stockholders are reported to be opposing the reconstruction scheme under which BMW will have the value of its capital written down to half and control will pass to the Daimler Benz-Auto Union group, ultimate control of which lies with Herr Flick, former German coal magnate. Officials say it will be the end of the firm is stockholders do not accept the reorganisation plan.

The world-famous Bavarian firm was completely dismantled after the Second World War and even after it was re-established, the production policy did not produce successful results. Expensive luxury sports cars were produced in numbers too small to be profitable. The BMW Isetta and 600 economy cars did not solve the problem. The new 700 has raised a lot of interest but production is only 40 a day, which cannot produce the profit needed. An arrangement with the Daimler Benz-Auto Union interests has been sketched out with the help of the Bavarian State Government. Under this scheme, BMW may help to build the 220 Mercedes waiting lists for which now run to 20 months on the German market. The big BMW models would be dropped but the 700 would probably continue. Motor cycle production would also continue, owing to its profitability.

BMW would get an initial transfusion of 24 million DM for one year free of interest. They lost 49 million DM during the ten years from 1949 to 1959. The new plan will write down original capital from 15 to 30 million DM and capital will then be increased to 85 million DM. Stockholders will be guaranteed a dividend of 6 per cent for 1960, 1961 and 1962.

Beauty Treatment for the 2CV

The distinction of being the ugliest car produced in the post-war era must surely go to the Citroen 2CV. However, this dubious distinction has at last been corrected by Citroen Cars Limited, Slough, Buckinghamshire, who are producing a British bodied version of this incredible little car. Known as the Citroen Bijou, this new model has truly sleek, attractive lines, incorporating the use of polyester resin reinforced glassfibre on the body.

A notable feature of this new plastics body is the way in which the entire bonnet assembly opens forward, giving exceptional accessability to the engine and front wheel transmission unit. The engine is still the 425 c.c., air cooled, 12 b.h.p. unit used on the original 2CV.

Light-luggage accommodation inside the car is good. There is a sizable parcel shelf in front, a window shelf and deep parcel pockets at the rear. The front seats are very easy to remove, a useful asset when cleaning or repairing the floor, as well as being a delight to outdoor picnic fiends. Other accessories include heater and demister, fresh air ventilation, windscreen washers, two sun visors and pile carpets.

Full-size wheels, interconnected front and rear springs which give notably smooth riding, four forward synchromesh gears (top overdrive), rubber suspended seats and a fuel consumption claimed to be around 60 miles to the gallon, all add up to a top class economy car—but theres' a drawback: the price in Great Britain, including purchase tax, is £674.

Over-production in India?

The endless call for more investment and more production in India has been going on for so long that it is a shock to find a leading Indian industrialist warning of possible difficulty in selling the products of his country's iron and steel works.

Sir Biren Mookerjee, chairman of the Indian Iron and Steel Company which was incorporated in 1913, announces in his annual statement a 16 per cent increase in his company's output of ingot steel over the previous year, and points out that various factors—including nine strikes during the year and works extensions—prevented the plants from working at full capacity.

His fear, says Sir Biren, is that when all the plants get into full scheduled production, there will be too much iron and steel produced. Without an extensive domestic market, the practice of calling for more and more production will, Sir Biren forecasts, instead of promoting, actually retard industrial development by making the manufacture of goods unprofitable, or the goods unsaleable.

Proposing changes in Government policy, Sir Biren calls it wrong to seek more production and less consumption. What India wants is more production and more consumption, and two of the most important changes must be the lowering of prices and the reduction of both direct and indirect taxes on the people. So long as the Government of India sees the establishment of new works primarily as a means of obtaining employment the cost of production cannot be reduced. Inflation has been pushing up the cost of living, and with it the level of wages; this has had a pronounced effect on industries already employing more than the necessary number of people.

The solution is seen by Sir Biren in more production and lower selling costs, the classic case of developing countries. The effects of the present situation on final costs are enough to price India " out of every foreign market worth capturing." The chairman of Indian Iron and Steel holds out no hope of excess home production being exported against strong foreign competition. This, he now sees, begins to include not only China but Australia as well.

Hawker's Bid for Blackburn

The concentration of the aircraft industry suggested by the Government over a year ago is proceeding, if only slowly, with the Hawker Siddeley group as the main prime movers. Their latest move is a bid of £4·4 million for the Blackburn group. The latter's board have recommended shareholders to accept what the *Financial Times* describes as a " fair if not particularly generous offer." Blackburn holders will receive their special 1*s* tax free capital dividend (out of the profits of a recent property sale) and will then exchange from a 10*s* share with a 10 per cent tax free dividend to a £1 share paying 10 per cent less tax. They will, assuming full acceptance, hold about 9·6 per cent of the enlarged Hawker equity, having contributed to the merger 7½ per cent of the combined book net assets and, on last year's performance, between 6½ per cent and 10 per cent of total net profits for the equity—depending on whether Hawker's exceptionally high " profits from earlier years " are included or excluded.

The two groups are complementary in certain fields, and when they overlap constitute a good hunting ground for rationalisation enthusiasts. There is no doubt that the merger is in line with Government policy, for which the industry has so far shown little enthusiasm—understandably enough from the sectional viewpoint of leading manufacturers. Blackburn were responsible for the Beverley freighter for the RAF and are currently engaged on the production of the NA-39 strike aircraft for the Royal Navy of which a " substantial number " were ordered recently. Blackburn are also studying " two entirely different projects " and have a number of developments on the engine side of the industry. They have substantial orders for the Palouste gas turbine for starting engines of Naval and RAF aircraft and are also making the Artouste for use as an auxiliary power plant. Other engines include the Turmo and the A129 gas turbine for which orders are expected for the Saunders-Roe P531 helicopter.

In addition they have a wide range of other interests including electronics engineering, lawn mowers, agricultural equipment and house building.

The merger makes Hawker one of the largest aircraft groups in the world. They include Gloster Aircraft, Armstrong Whitworth, A. V. Roe, Avro Canada, and other firms engaged in the manufacture of components. Since last January they have merged Armstrong Siddeley Motors with Bristol Aero Engines to form Bristol Siddeley Engines owned equally by Hawker and Bristol, and acquired the share capital of Folland Aircraft.

Capital Goods Conditions

A slight upward trend in orders, although the order book was not as full as at this time last year, was reported by Mr. Frank Morris, chairman and managing director of Herbert Morris, makers of lifting and transporting machinery, in his annual statement.

Mr. Morris covered well known ground when he described the recovery of the almost-past year as mainly in consumer goods and slow to spread to capital goods industries, which lagged behind in the revival. Despite the failure of industrial orders for capital equipment to equal the capacity available to meet them, Herbert Morris were able to maintain production at a " comparatively " high level, although profit margins, as elsewhere, were reduced.

The parent company's net trading profit for the year was £362,555, a reduction on the previous year's total of £497,098.

The conditions for the crane trade in Canada and Australia, where Herbert Morris have interests, were not favourable, but the group's South African company had a satisfactory year. Some interesting developments may follow from the company's purchase during the year of the entire shares of British MonoRail Limited.

The chairman recalled the forecast of the Board of Trade that capital expenditure by industry in 1960 was likely to be lower and not higher.

United Steel Expands

The 21 open-hearth steel melting furnaces of Steel, Peech and Tozer, one of the United Steel Companies, are to be replaced in a £10 million development by six electric arc furnaces. Over the next three to five years this will raise the company's output of a million ingot steel tons to a maximum of 1,350,000 tons.

The Rotherham melting shop is to be demolished and the six new furnaces, each of 110 tons capacity, will be put up at the Templeborough shop.

Some idea of the demands the steel industry of the future will make on other sectors of the nation's industry is given by the facts being set out in United Steel's talks with the electricity supply people. The new equipment will have a power intake six times that of the furnaces being replaced. The six electric arc furnaces will consume power equal to a third of the present industrial loading of the Sheffield area.

This combined expansion and modernisation by the subsidiary Steel, Peech and Tozer is part of the overall United Steel, forward plan which estimates that last year's investment of £14 million will continue to be the average over the next five years.

Marconi Achievements

The Marconi company has adopted an international policy for the whole of its long life but not often has it been able to report such widely spread results as the completion last month of nine broadcasting stations, all but two of them out of the United Kingdom.

The value of the contracts was £600,000 and the installations fitted into the contemporary scene in being partly in member countries of the European Free Trade Area, partly in the Commonwealth and partly for regional development in Britain.

Seven of the stations were for television. They were set up in Australia, Nigeria, Sweden, Northern Ireland and Kenya. In Australia Marconi supplied vision transmitters, sound transmitters and programme input and ancillary equipment for two stations, both at Brisbane. They are the Government television station and the commercial. In this second phase of Australian television development, stations are also to be opened at Adelaide, Perth and Hobart. Marconi will be supplying the main transmitting and studio equipment for Adelaide and Perth and studio equipment at Hobart.

The Nigerian Government stations, the first permanent African television service, are at Ibadan and Abafon, both equipped with Marconi vision and sound transmitters and studio and ancillary equipment. The company also has the contract for station maintenance for the next year.

The Swedish station, one of five ordered from Marconi, has the company's transmitters, programme input and ancillary fittings, but is not yet on the air as the aerial—not this time by Marconi—is not complete.

The two sound stations are in Kenya and Peterborough. The Kenya, Langata, station has eight transmitters putting out programmes in African, English and Asian. For the BBC at Peterborough Marconi have provided six Band II 900 W FM transmitters.

Cable Battle

The chairman of Aerialite Limited, Mr. L. S. Hargreaves, discusses in his annual report the price war in the electric cable industry and the low profitability of most of the companies taking part. The experience of his company, he said, would have been serious had they not already diversified their manufactures and markets. The fall in group profits from £469,000 to £366,000 for the year ended 31 May would have been much worse " had not economy and effort enabled the group to remain reasonably profitable in its operations in the cable business and had not other activities made their contribution to revenue."

The larger companies have fared better, though not as well as might have been expected from the amount of business obtained. The colossus of the industry, British Insulated Callender's Cables, showed increased sales for the half year to 30 June—from £57 million in the half year to 31 December, 1958, to £63 million—but slightly lower trading profits at £4·81 million. The new figures include, for the first time, those of Telegraph Construction Company and Scottish Cables, from January and April of this year respectively, following their acquisition by BICC. The profitability of BICC is relatively low, despite their great strength. In the half year under review the gross margin was 7·6 per cent, as against 7·5 per cent in the first half of 1958 and 8·5 per cent in the second half. Prospects of participation in projected world cable link are encouraging although outlook in other directions remains uncertain. Discussion now taking place in the industry may eventually create a better situation.

Visualisation of Plastic Flow Patterns

An analogue device which will give a visual indication of the two-dimensional flow of a plastic substance under imposed deformations has been developed. Both the apparatus and the method of working it are simple and inexpensive.

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The motion of a substance under the influence of complex forces is determined in some limited, ideal cases, by a mathematical treatment involving limiting conditions not always directly related to practice. The author has developed a relatively simple analogue which uses a plastic earth upon which deformations are imposed so that the resulting distributions of pressure produce a flow pattern which can be visualised and recorded.

The principle involved in this apparatus is to pack a space with suitable strips of earth dyed in different colours. By a suitable arrangement of the space the application of a force produces a pressure distribution in the strips of earth which causes them to flow locally in a direction proportional to the local force vector.

This method of visualising plastic flow can possibly be extended to study problems in a wide range of rheological substances and may even include the study of some viscous motion. At this stage its use is envisaged in some of the following problems:

(1) The plastic strain on bodies of an irregular shape under conditions somewhat similar to those for which the photoelastic apparatus is applied (it is thought that this method might at least be of some demonstrative value in educational fields).

(2) The extrusion of plastic substances and molten metals through dies.

(3) The deformation of foundations and the pattern of earth pressures.

(4) The motion of fluids under the piston in dashpots and the effect of piston configuration on the efficiency of performance.

APPARATUS

The initial experiments were made with the apparatus shown in Fig. 1. This illustration is mostly self-explanatory except that the face of the plunger can be produced in a series of shapes to represent the form of deformation required. In this instance a plunger shape is itself indicated. A space must always be provided in the apparatus into which, or through which, flow can take place.

Strips of coloured Plasticine 0·25 in wide, 0·75 in deep were prepared from large lumps by extruding them through a nozzle incorporated in a simple mincing machine. These strips were then cut off into 4·5 in lengths and placed in the space beneath the plunger. At the beginning of this development these strips were dipped in ordinary mineral oil to introduce a viscous effect between the layers, but it was found that in general this oil became squeezed out and it had no noticeable effect on the viscous flow. The tests reported here were carried out with the ordinary, unlubricated strips.

With the strips in position and the plunger screwed back, the Perspex cover was screwed down. A clamp was prepared and applied over the whole area of the Perspex since it was found that without such a restrictive influence the Perspex deformed outwards and the Plasticine strips diffused over the adjacent sections producing a film effect (which can be seen in one or two photographs). With firm clamping the individual strips maintained their identity.

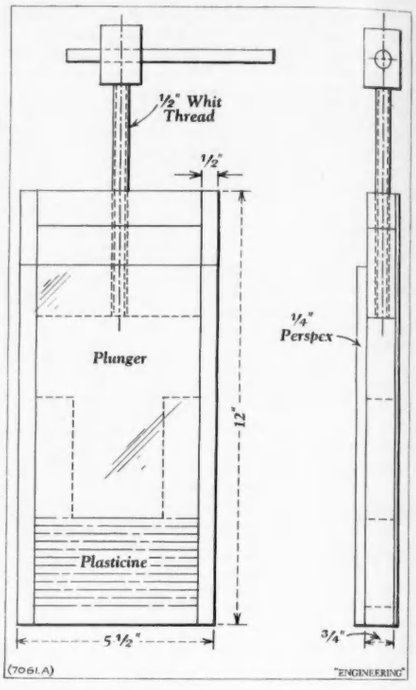


Fig. 1 A simple analogue device for simulating plastic flow patterns.

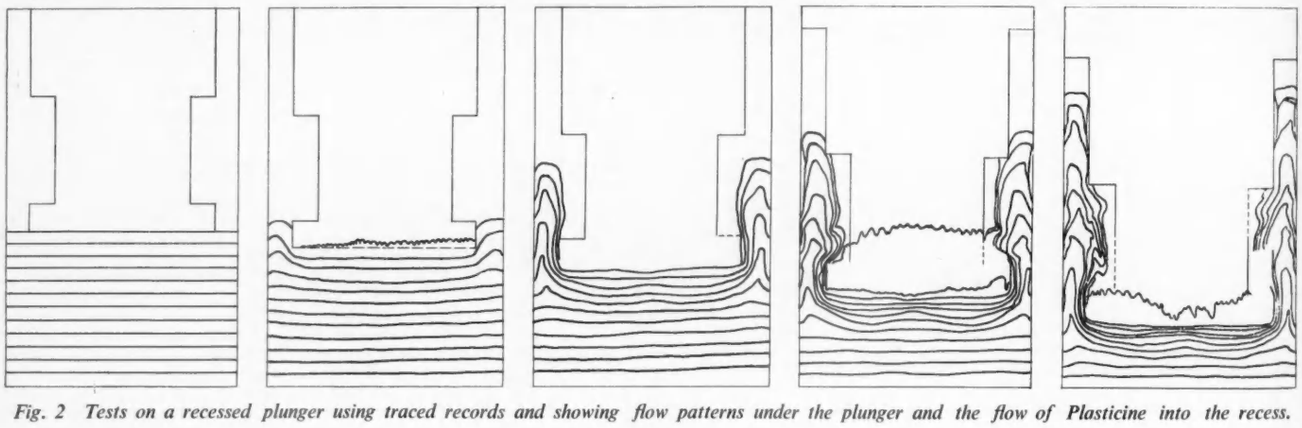


Fig. 2 Tests on a recessed plunger using traced records and showing flow patterns under the plunger and the flow of Plasticine into the recess.

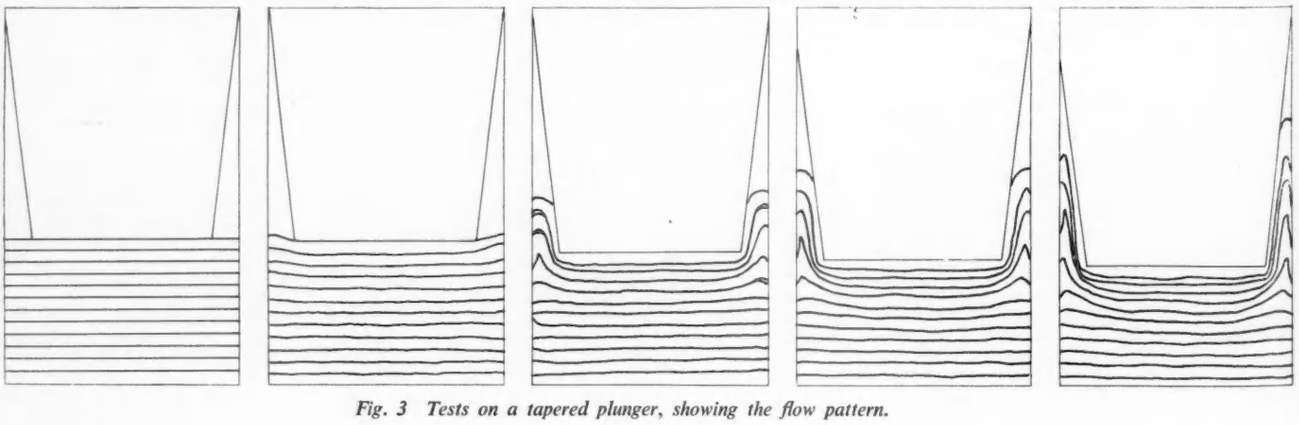


Fig. 3 Tests on a tapered plunger, showing the flow pattern.

TEST PROCEDURE

A record was taken of the apparatus in the initial position with the Plasticine in place by photographing the appearance of the series of strips and also by placing a tracing paper over the whole assembly and tracing the boundaries of the adjacent strips of coloured Plasticine.

The clamp was applied and the screw turned very slowly and regularly for one turn. After a period of approximately two minutes the clamp was removed and a record made of the flow lines. With even a very small movement of the plunger a noticeable disturbance occurred to the strips of Plasticine.

This procedure was then repeated, the clamp being re-applied and the screw operated, followed by the recording of the flow lines. In this way a complete sequence of the flow pattern was produced. By placing the series of tracings in their respective orders on top of each other the actual movement between adjacent strips was clearly observed.

The procedure of tracing the patterns was very laborious and it was found to be more convenient at a later stage to photograph the apparatus with the clamp removed and enlarge the part showing the flow.

EXPERIMENTAL RESULTS

The effects of a complete series of tests are shown in Fig. 2 and Fig. 3, where the flow has been recorded by tracing on paper laid over the perspex. Photographs taken at the initial position and at the end of the test are given in Fig. 4 and Fig. 5.

To secure an alternative pattern with the strips arranged in the same direction as the motion of the plunger, tests were carried out, which produced the results shown in Fig. 6 and Fig. 7.

The method appears generally to give a more realistic impression of the plastic flow if the imposed deformation is applied in the manner of the first series of tests with the strip at right-angles to the direction of the applied force. An orthogonal effect can certainly be obtained by testing an arrangement with the strips alternatively in one direction and then in another. Preliminary sketches of the orthogonal patterns (which bear some relationship to the pressure distribution) showed that close agreement could be obtained by experimental testing in this manner.

The existence of a flow pattern under the applied load is indicated quite clearly at all positions of the plunger. In the case of the plunger with a recess, a form of divided pressure distribution with three maxima or peak positions was shown up with two effective zones while in the case of the tapered piston a more conventional pressure distribution with a single maximum position appears to be formed.

A further feature demonstrated by these observations was the way in which the material flowed in the region of the plunger but that some way towards the base the arrangement of the strips was undisturbed, little or no flow having taken place.

A final test to assess the adaptability of this method to other forms of investigation is shown in Fig. 8. In this experiment a " bar " of several strips was pressed against a discontinuity comprising a solid block and a spring loaded resistance. The resulting flow pattern bears some resemblance to that which might be presented by a photo-elastic analysis.

Additional investigations are proceeding to explore the effects of various waxes and granular materials as the operative materials; to relate the deformations to definite applied pressures and to determine a relationship with the theoretical distributions.

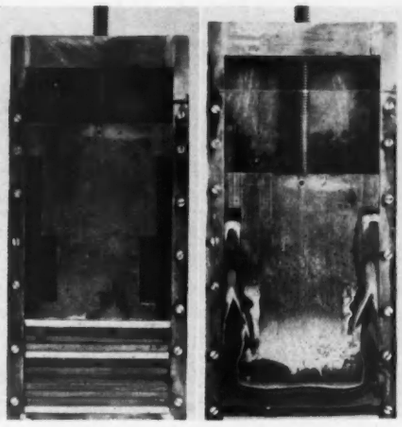


Fig. 4 Flow under a recessed plunger.

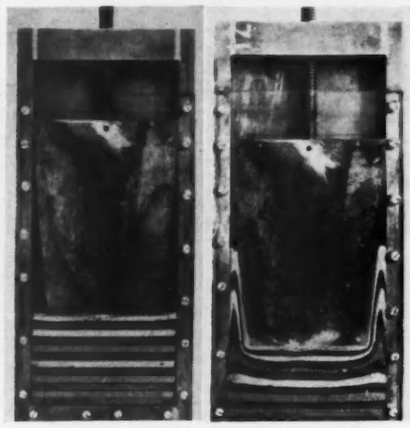


Fig. 5 Flow under a tapered plunger.

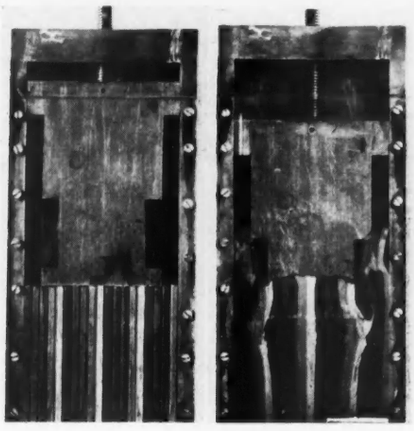


Fig. 6 Plasticine layers arranged vertically under a recessed piston.

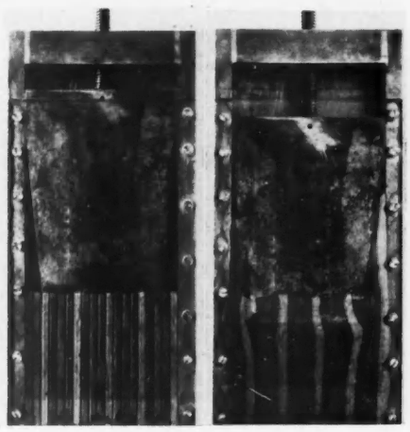


Fig. 7 Vertical layers under a tapered piston.

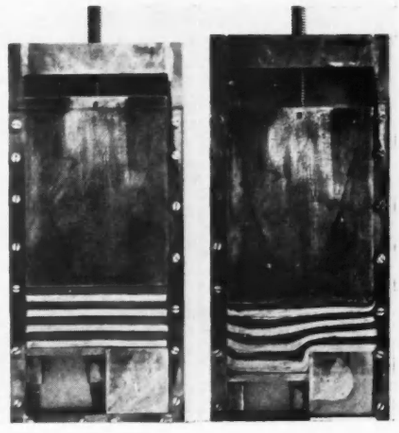


Fig. 8 (right) Flow pattern of bar with discontinuity, under steady load.

Experiments in the Upper Atmosphere

Some time last spring it was internationally agreed to launch an " attack " on the upper atmosphere by simultaneously firing different rockets in various parts of the globe, each carrying identical or related experiments. The British contribution to this combined effort was developed jointly by the British National Committee on Space Research, set up by the Royal Society, and the Royal Aircraft Establishment.

The programme was to launch three Skylark rockets; all of which were successfully fired from Woomera, Australia, in the short space of 36 hours at the beginning of December. The first Skylark carried the sodium vapour experiment which was devised by the Queen's University of Belfast. Sodium vapour, ejected from the rocket at heights about 40 miles, gives a resonance glow when observed under the correct twilight conditions. Optical observations of this glow, made with interferometers ballistic cameras, are expected to give data on both atmospheric temperature and wind structure.

The second Skylark was to measure the atmospheric temperature and horizontal and vertical wind speeds up to heights of 90 miles, using a sound-ranging method. This experiment, devised by a special group at the Physics Department, University College, London, was based on the optical and acoustical observations of explosive grenades ejected from the rocket at regular intervals. In addition metal foil was ejected from the rocket and observed by radar enabling an independent estimate of wind speed and direction to be made by the Department of Meteorology, Imperial College, London.

The third Skylark carried three experiments: the first for the measurement of atmospheric temperature and horizontal and vertical wind speeds using the grenade sound ranging method (University College, London); the second, measurement of wind characteristics by using radar observations of metal foil ejected from the rocket (Imperial College); the third, measurement of electron densities in the ionosphere (Department of Electron Physics, University of Birmingham).

Firing Models to Reach Hypersonic Speeds

Hypersonic speeds are important to space research. But they are difficult to use in the laboratory. One way is to shoot models from high velocity guns. Behaviour in hypersonic free flight can then be studied.

Behaviour of material objects at hypersonic speeds, notably on re-entry into the atmosphere has many aspects: trajectory, heat transfer, flow patterns, radiative emissions, interactions of shock-generated plasmas, and ablation. Not a simple subject. In fact, much experimental work will have to be done before the interaction of the various aspects can be understood.

A difficulty with experimental work in this field is the very high energy required to reach re-entry velocities, which can exceed 30,000 ft per second. One way—used on the Woomera rocket range in Australia—is to fire a nose cone into space and to find out what happens to it on its return. Five shots of this type have been made with Black Knight rockets, the latest exceeding Mach 10. In the laboratory, wind tunnels have been designed to produce Mach 8 or, for very short intervals, up to Mach 15. The inverse of the wind tunnel, the hypersonic gun, promises higher velocities. Present types shoot models in free flight at velocities up to 20,000 ft per second; and guns under development may fire models at 30,000 ft per second.

A description of the use of the gun technique at the Canadian Armament Research and Development Establishment is given in a paper "Re-entry Studies in Free Flight Ranges," by G. V. Bull (Institute of the Aeronautical Sciences Paper number 59-143). A typical hypersonic gun range is shown in Fig. 1. It consists of a gun, a dump tank to absorb gun gas, the range itself, instruments and pumping gear.

THREE GUN TYPES

Guns for ranges like this use light gases, to produce high operating velocities. Conventional guns using solid charges are limited to between 7,000 and 8,000 ft per second. At CARDE three guns are in operation, having various bores. The one illustrated in Fig. 2a is the simplest. It is a 14 in bore gun with a chamber 15 ft long and 16 in diameter; the full barrel length is about 110 ft. As in all such guns, the model to be tested on the range is carried in a sabot, which transmits gun gas pressure to the model and protects it during acceleration down the barrel. Hydrogen and oxygen are ignited in the chamber and the flanged base of the sabot acts as a diaphragm, retaining the loading pressure until it shears at some value before peak pressure. Projectile velocities of 14,000 ft per second have been reached with this gun.

A second type of gun used at CARDE is shown in Fig. 2b. This has been designed to overcome the high loading pressures and detonation problems encountered in the previous design. Under typical loading conditions the ignition of the gas mixture produces a pressure rise of 7 : 1 and a gas escape speed of 50,000 ft per second. The model diaphragm is strong enough to withstand this pressure rise. But as the flame front reaches the thin-web standard-cordite propellant at the upstream end of the chamber, rapid burning occurs resulting in the forward propagation of a shock front, compressing the hydrogen-steam mixture by a 3 : 1 ratio; on reflection of the shock at the diaphragm a further compression of 3 : 1 results in a region of gas being produced with an escape speed of about 65,000 ft per second. The enhanced pressure is sufficient to break the diaphragm. The projectile is then shot down the barrel.

This system should be capable of achieving velocities between 15,000 and 16,000 ft per second. However, the CARDE gun has initially only produced velocities below 13,000 ft per second. The reduced performance may be due to gas leakage, model-barrel instability, or mixing of the propellant gases with the hydrogen-steam.

The third type of gun is shown in Fig. 2c. It is a 0·55 in bore multi-stage shock-compression gun. Basically the system uses a gas gun to accelerate a piston rapidly so that it acts as a typical shock tube piston, shock compressing a volume of pure gas (helium or hydrogen) to the necessary enthalpy conditions. The gun produces velocities of 17,000 to 20,000 ft per second.

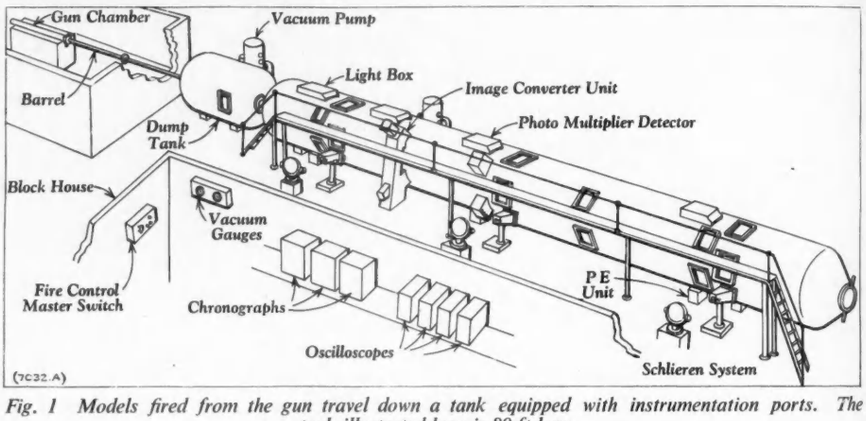


Fig. 1 Models fired from the gun travel down a tank equipped with instrumentation ports. The tank illustrated here is 80 ft long.

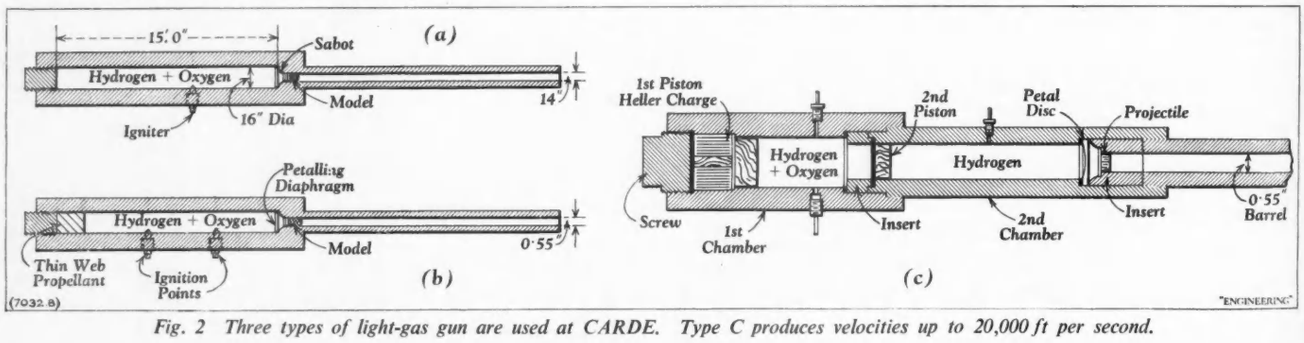


Fig. 2 Three types of light-gas gun are used at CARDE. Type C produces velocities up to 20,000 ft per second.

SABOTS AND TANKS

At present model and sabot design is developing very rapidly. It is one of the least understood aspects of range technique—chiefly because of the unknown properties of materials under shock loading conditions. In standard guns, for example, initial accelerations reach 160,000 *g*.

Once clear of the gun muzzle, the sabot must separate from the model. Aerodynamic separation, using drag, is generally the method. A region for separating and trapping the sabot is provided by the dump tank, which also serves to absorb gun exhaust gases, preventing them from entering the range proper.

At CARDE the ranges are long cylindrical tanks with observation and instrument ports along their length. Tank size varies from that used with the 0·55 in gun (25 ft by 2 ft plus 25 ft by 3 ft) to that used with the 14 in gun currently (400 ft by 10 ft, with planned extension to 1,200 ft by 15 ft). Tank pressures between 10^{-2} and 10^{-3} mm mercury are attainable. Should dump tank and range pressure be unequal, a diaphragm is used to separate them.

For studies concerned with aerodynamic stability and control, accurate measurement of each free flight trajectory mode is called for. To get pitching moment, normal force, damping, and roll data, at least two complete cycles of trajectory must be observed. At low pressures this means long ranges—400 ft or more. Direct measurement of heat transfer parameters in range tests is becoming possible with the development of miniature telemetry equipment capable of withstanding gun launching loads. Under certain conditions, body temperature characteristics can be inferred from measurement of emitted radiation, but at present the technique is so severely restricted by spatial resolution and inter-action problems that it is of little value. Body temperatures of 1,000° F are predicted.

Studies in aerophysics are also carried out on the range. The shock generated plasma about high velocity objects is a mixture of gaseous and ablation products, generally relaxing towards equilibrium conditions. Such plasmas as appear around the body and wake regions can be studied by the techniques of classical physics. To date, most observations have been made by optical and microwave spectroscopy. Study of the emission spectra of high speed aluminium projectiles in rarified air, for example, revealed vibrational progressions of the A10 bands corresponding to effective vibrational temperatures of 3,500° K. Ten centimetre radar measurements, with signals transverse to model trajectory, show the size and electron density of the plasma sheath around the model : in general, sheath size is proportional to model velocity and the reciprocal of tank pressure, extending for lengths of several feet at moderate values of pressure and velocity.

On the Shelf

By Frank H. Smith

Having made a song and dance about members of Aslib Engineering Group not supporting their visits, I proceeded to let the secretary down myself in their visit to Whitefriars Glassworks in November. It served me right that I missed one of the best. The secretary kindly supplied me with her impressions. Hardy men sitting between open windows and oil furnaces in shirtsleeves, using up to one ton of molten glass a day making vases, ashtrays and paperweights. Each article has three men working on it as a team.

Miles of thermometer tubing stretched out by machine like the child playing with chewing gum. Stained glass windows are produced, and when a particularly difficult colour is asked for the ingredient mixers take a great joy in getting just that colour with a minimum of fuss. At Whitefriars there is a great tradition and pride. When the works moved from London to Wealdstone live coals were transported so that the furnace could be claimed never to have expired.

I feel I am justified in saying that I can recommend a certain reference book because I know the author personally and know him to be a scrupulously accurate man who knows what he is talking about. J. L. Nayler, who was secretary of the Aeronautical Research Council for longer than many of us have lived, has compiled *Dictionary of Aeronautical Engineering*. Newnes do it for 30*s*.

While the literature on how to write a decent report grows, little attention is paid to the technique of the oral presentation of information. In General Motors' *Engineering Journal* for the last quarter of 1959, R. P. Wilcox writes on "Characteristics and Organization of the Oral Technical Report." Much that he says could throw a spanner in the works of those conferences where papers are both delivered and subsequently printed. Wilcox makes many points of difference between a well-presented spoken paper and a ditto written one. It's food for thought anyway.

In early November was published the first number of *E.F.F.I.*—bulletin of the electronic forum for industry (and the electronic forum consists of BEAMA, BRVMA, EEA, MTTA, OABETA, RECMF, SIMA, and TEMA). In this bulletin are articles based on papers read at an open day of the forum held earlier this year with such titles as "Industrial mathematics" (by a Ferranti man), "The computer centre serves as a practical approach to computer usage" (by an ICT man), "How analogue computers can aid industry" (by an EMI man), and "Data reduction in the aircraft industry" (by an SBAC man). Now with all those initials to play with you will need neither *The Times* nor the *Daily Telegraph* Christmas quizzes, will you?

It looks as though the general manager of GB Film Library (Aintree Road, Perivale, Greenford, Middlesex) could well get a part-time job as a circus ringmaster, judging from the opening stanza of his letter: "Here it is at last." However, he is quite right. Their "Entertainment Catalogue" for 1959-60 of 16 mm sound film really is a fascinating piece of work (I've got the fever now—I sound like a publicity man for a film actress) with over 30 classifications such as Walt Disneys, Mysteries, Mystery Shorts (no comment), Sooty films (ha ha), Muffin the Mule, Westerns—the lot. In fact, you can chuck away the television and buy a projector forthwith. Mind you, you'll want a few neighbours to dig in with the hire fee but you do have the choice of picking NN (unsuitable for children), NCC (suitable for the over 14's), NC (for adults), GC (excellent for children). I've not time to pick out the NN's for you so you had better get your own copy. Half-a-crown and worth it for the stills alone.

YOUNG PEOPLE'S GUIDES TO MEN AND MACHINES

Turbines. By FREDERICK E. DEAN. *Frederick Muller.* (9*s* 6*d*)

Internal Combustion Engines. By EDGAR T. WESTBURY. *Frederick Muller.* (9*s* 6*d*)

Turbines, by F. E. Dean, and *Internal Combustion Engines*, by E. T. Westbury, are two contributions to a useful new series called "The Mechanical Age Library," of which Mr. Dean is himself the general editor. The series is intended to introduce young enthusiasts to various technical subjects, and judging by these volumes it should succeed. Both are sensibly arranged, beginning with first principles and covering the main types and modifications; and they are illustrated with photographs and bold clear diagrams. The approach is critical as well as descriptive: we are told what the different machines are good for, what their limitations are, and how they have been or are being improved. Brief historical comments convey a sense of unity and growth.

Mr. Westbury stresses first the applications of the internal combustion engine for transport and industry, and concludes with discussions of "unorthodox" engines and new developments. Mr. Dean, in view of the variety of turbines, prefers to emphasise method of working rather than application, and his chapters are headed "Water Power," "Gas Turbines" and so on. Where the topics are so wide there must have been doubts about what to include and what to omit. So it is that Mr. Dean devotes a concluding chapter to an admirable fundamental discussion of atomic fission and the working of atomic reactors in conjunction with turbines. Mr. Westbury, on the other hand, although he stresses the importance of gearing in connection with the internal combustion engine, refrains from explaining the operation of a gearbox.

The claim that the books are written in "non-technical language" is, of course, an exaggeration (a typical sentence reads "This engine appears to have worked very successfully, but the volumetric efficiency and working pressure were low, resulting in very poor fuel economy"). What can be claimed is that in general they ask no more of the reader than a basic scientific vocabulary and a serious interest in the subject.

More Power To You. By HERMAN and NINA SCHNEIDER, illustrated by BILL BALLANTYNE. *Brockhampton Press.* (10*s* 6*d*)

A surprising amount of the same ground is covered in *More Power to You*, a book about man's progress in manufacturing power, which is designed for children of perhaps 10 to 12 years. It is an excellent example of a book about science which avoids technical language (although not, of course, technical words).

Mr. and Mrs. Schneider's respect for language is equalled by their respect for their subject and their readers. (They are American, incidentally, and their book appears to have been discreetly edited for publication here.) Their sentences are lucid, and their careful handling of questions and paragraphs should encourage children to read on and satisfy their curiosity. A few simple but illuminating experiments are suggested and there are many attractive drawings.

An impressive feature of *More Power to You* is the use of the sun as a unifying theme. We are shown how all the older forms of power depend upon the sun; only atomic energy is a challenge to it. Perhaps the authors have in mind a comparison with the Renaissance: whereas then man seemed in danger of destroying his soul by proclaiming his independence of God, now he is liable to destroy his physical self by his independence of the sun. In his attempts to control the nuclear fusion process—the sun's own source of energy—he may even be guilty of hubris. Anyway, the authors conclude by inviting their young readers to think about the universe and the achievements of man: "people also use these wonderful things to destroy life. . . . The power itself cannot choose; only man can do that. How would you wish it to be?"

Six Great Engineers: De Lesseps, Brunel, Westinghouse, Parsons, Diesel, Hinton. By J. G. CROWTHER. *Hamish Hamilton.* (12*s* 6*d*)

Six Great Engineers, one in a series of half dozens, is an undistinguished effort which often reads like notes from the standard source books arranged in paragraphs (there are short lists of references after each biography). Apart from some remarks in the chapter on Sir Christopher Hinton which seem to derive from personal experience, there is little indication that the author is involved with his subjects; the main figures have but two dimensions, and the minor characters one less. The occasional comments and judgments are safe and simple. On the other hand, the author has shown some imagination in his choice of subjects.

One of the hardest tasks of the biographer (much more so with engineers than with artists) is to show the relationship between a man's life and his works. Mr. Crowther's failure in this direction (and the inconsequence of his paragraphing) is exemplified in a paragraph on Sir Charles Parsons. After telling us of the great speed at which he worked on his compound turbine it concludes: "He took out his master patent shortly before the birth of his first child, Rachel Mary. His second child, Algernon George, was born less than two years later." What effect, one is inclined to ask, could the patent have had on young Algernon?

If Mr. Crowther has been able to bring little that is original or perceptive to his biographies, at least he has not obscured the facts; and since the lives are for the most part so extraordinary, the book should appeal to children. They may learn from it those traits which have marked the great engineers: determination, creative insight and an astonishing versatility.

BOAC Book of Flight. Edited by BARBARA COOPER. Published in association with the British Overseas Airways Corporation by *Max Parrish.* (16*s*)

Here are two of those large profusely illustrated volumes which are so useful for giving to nephews as Christmas presents.

The *BOAC Book of Flight* is a publicity venture and so gives a somewhat one-sided picture of commercial flying; however, its colourful, glossy format and jolly style (much of it of the "Five hours later—Karachi!" variety) are in the true tradition of annuals. There are some well-diluted facts and figures, a few diagrams and many photographs: topics covered include the history of long-distance flights, weather forecasting, catering and "strange cargoes." A chapter by Harry Hensser, O.B.E., chief photographer of BOAC, contains some striking and beautiful views.

Boys' Book of Flight. By DAVID LE ROI. *Iliffe.* (12*s* 6*d*)

The *Boys' Book of Flight* was published in a revised edition last year. It contains 23 sections on jets, rockets, flying history and aircraft applications (including several military ones). Although some effort is made to explain simply the basic principles involved, the text sets a high technical level (similar to that of the "Mechanical Age" series), and consequently can only be recommended for older children with keen interest in aircraft. The Russians put the first edition of the *Boys' Book* out of date by launching the Sputnik; now with a rocket round the moon, a second revision is called for.

COLIN J. ALBU

DON'T DO IT YOURSELF

The Techniques of Delegating—How to Get Things Done through Others. By DONALD A. LAIRD and ELEANOR C. LAIRD. *McGraw-Hill.* (31*s*)

The suspicion engendered by an American management textbook with the title *The Techniques of Delegating* is not diminished by the discovery that the same authors have been responsible for *The Techniques of Getting Things Done*, *The Techniques of Personal Analysis*, *The Techniques of Building Personal Leadership*, *The Techniques of Handling People*, and half a dozen others.

There is some justification for suspicion; the book is padded out with superficial " case studies" and uncritically reported results of " research studies," and tends to be repetitive and oversimplified. Nevertheless, the subject is an important one, and what the authors have to say about it is essentially sound and worth saying.

Delegating is a vital part of management: the subtitle of the book " How to Get Things Done Through Others," might well be used as a definition of management itself. True delegating involves passing on part of the decision-making and responsibility for a task as well as its executive details. This, in turn, requires selection of suitable subordinates; advance planning of the jobs to be delegated so that too much is not expected too quickly of the subordinate; willingness to accept the inevitable errors of judgment which are the price of learning by experience; the exercise of control, informal and flexible though it may be, to minimise the consequences of errors and to ensure that their lessons are learned. All of which amounts to a sizeable long term project—nothing less than " the development of the human resources in the enterprise," which is the foundation of the growth of any organisation.

There is, of course, much more involved in all this than delegating, and this is the root of the authors' difficulty. In attempting to deal with one facet of management in isolation, they are compelled to gloss over other aspects which are equally important and scarcely separable from delegating—personnel selection, aptitude assessment, training, methods of management control.

In the event, they are driven back to stating principles and axioms which seem obvious once they are stated. This is not necessarily a bad thing. However obvious and common-sense the principles may appear, it is not difficult to think of many cases where they are not applied, and of companies handicapped by the inability of a senior executive to delegate. (Engineers, the authors note, " are particularly likely to overlook or dodge delegating ").

The book does, however, raise in an acute form the whole problem of writing on management subjects. Which is the most useful approach—to expound principles which ought to be obvious, even if they are not always applied, to conduct a general survey of current practice, or to study two or three real cases with depth and perception? There is no doubt that the case-study in depth is by far the most rewarding (as, for example, in Lynton's *Three Studies in Management*), but the current American market for management textbooks appears to demand an attempt to combine the three methods indiscriminately. The authors make their own comment on the project: " adequate delegating remains an art. It is not picked up from a book read on some week-end." And certainly not this book! But in so far as it provokes thought on an important aspect of management and directs it along sound lines, the book serves a useful purpose.

V. C. NOLAN

GENTLE PUBLISHER

Blackie and Son, 1809-1959. A Short History of the Firm. By AGNES A. C. BLACKIE. *Blackie and Son.* (10*s* 6*d*)

Every publishing house has its own character. Blackie and Son, who have produced this handsome book in celebration of their 150th anniversary, perhaps convey above all a concern for serious and uplifting topics.

In the early days, when the firm's interests were confined to Glasgow, a large part of its output consisted of religious commentaries. With the rise of genteel Victorian reading it turned more to works of general knowledge and " literary gems." The Education Acts (1870 and 1872) produced a tremendous demand for books which were exactly in the firm's line. The result was not only textbooks but also the " Rewards " series suitable for school prizes, which included the works of perhaps Blackie's best-known author—G. A. Henty.

Science had been represented as early as 1838 with *Theory of the Differential and Integral Calculus;* and 1843 saw the publication of *The Engineer and Machinist's Assistant.* However, it was the employment of the late Frederick Besacre, an engineer distinguished both academically and in industry, which resulted in a new high standard for Blackie's scientific works. Books published since then have included Prandtl's *Essentials of Fluid Dynamics*, Max Born's *Atomic Physics*, and the recent voluminous *Hydro-Electric Engineering Practice.*

Agnes Blackie has written an elegant text. There are pictures of all the directors and a photograph of staff with over 50 years' service; two early portraits (one, as we learn from the text, by Raeburn) ought to have been given proper inscriptions.

COLIN J. ALBU

TRADE PUBLICATIONS

Materials

SG Iron. THE MOND NICKEL CO. LTD., Thames House, Millbank, London, SW1. 36 pages of what SG iron is, how it can and where it is being used. The section on properties is technically detailed, covering such subjects as fatigue and thermal properties, hardness, wear and corrosion resistance. Uses are shown in power, transport, mining and chemical plant, civil engineering and agriculture. Booklet.

Process Plant. CHEMICAL ENGINEERING WILTONS LTD., Bird Hall Lane, Cheadle Heath, Stockport. Some of the principal Wilton chemical engineering specialities are illustrated and briefly outlined in this 8 page brochure.

Foliac Colloidal Dispersions. GRAPHITE PRODUCTS LTD., Northfields, Wandsworth Park, London, SW18. The emphasis is on colloidal graphite dispersions. An elementary introduction, saying where and when to use. There is a companion leaflet on its use in the power station. Leaflet.

The Stripa Process. HEAD WRIGHTSON COLLIERY ENGINEERING LTD., 46 Rutland Park, Sheffield. The Stripa process is a sink-or-float separation method for upgrading poor quality ores. It has been used in Sweden for treating 140 tons per hour of iron ore. Leaflet.

Cyclone Washer. HEAD WRIGHTSON COLLIERY ENGINEERING LTD., 46 Rutland Park, Sheffield. The development of the cyclone washer capable of high accuracy separation of mineral ores in the lower size ranges. Flowsheet for a typical plant based on the process using magnetite medium is shown. Six page booklet.

Rigidex Polyethylene. BRITISH RESIN PRODUCTS LTD., Devonshire House, Piccadilly, London, W1. After introduction on basic (non-technical) properties, instances are given of use for blow moulding, extruded sheets and film, and of its incorporation in various forms in such things as ropes, pipes and cables. Well illustrated 19 page booklet.

The Reviewers

Mr Colin J. Albu is employed by a firm of management consultants. In spite of early interest in mathematics he took a degree in English at Cambridge; and he is particularly interested in problems of technical exposition. The son of an engineer, working with engineers, but not an engineer himself, Mr. Albu is able to see engineers and their activities with a spectator's clarity and perspective.

Mr V. C. Nolan is an economist on the staff of Martech Consultants Limited. He is a graduate of Oxford University and has spent the last 7 years working as a consultant on a variety of management problems in industry and transport.

NEW BOOKS

Baustatik. Theorie und Beispiele. By KURT HIRSCHFELD. *Springer-Verlag.* (76·50 *DM*)

This 800 page book on structures covers the syllabus of a Continental engineering course, and is addressed also to the engineer already in practice. In assessing its contents and merits, it must be remembered that in general a continental student spends five years before receiving his diploma, and is then automatically " chartered " as an engineer. The book follows the usual exposition of the subject, and numerical examples are given in each section, many of them being solved by different methods as they arise; tables are used extensively to reduce labour of calculation in standard problems. Statically determinate structures are treated by the method of sections, by virtual work, Betti's and Maxwell's theorems, and so on, all these methods being expounded fully. A chapter follows on the solution of linear simultaneous equations. The theory of redundant structures again introduces no new material, but the scope is broad, and covers some simple space frames as well as fairly complex plane structures, and some attention is given to plates on elastic foundations. As is usual with books from Springer, the typesetting and illustrations are excellent.

Allgemeine Schalentheorie und ihre Anwendung in der Technik. By W. S. WLASSOW. *Akademie-Verlag, Mohrenstrasse 39, Berlin, W8, Germany.* (75 *DM*)

This book is a translation from the 1949 Russian work on shell theory and its application, prepared by a team under Professor Kromm at Dresden. As in all expositions of the subject, the mathematics is fairly heavy, and the author is concerned to leave very few mathematical loopholes. The first section of the book deals with membrane theory of shells of rotation, and with second order (parabolic, elliptic, hyperbolic) shells, and the second section develops the full theory of bending. In the third section the full theory is simplified for the case of thin shells (that is shells whose thickness is small compared with the radius of curvature), and the fourth section deals with medium length cylindrical shells. Finally, a section is devoted to structures made from thin *flat* segments. Despite its length (650 pages), the book has very few numerical examples, although the last 50 pages consist of tables for the solution of practical problems.

Seventh Symposium (International) on Combustion, *Published for The Combustion Institute* by *Butterworths Scientific Publications.* (224*s*)

This symposium was held at London and Oxford in 1958. Here are 124 papers on eleven aspects of combustion. They are in English and take 960 pages of text. Even so, over 70 of the submitted papers do not appear.

Die Drahtseile in der Praxis. By RICHARD MEEBOLD. 3rd Edition. *Springer-Verlag, Berlin.* (12 *DM*)

This well-illustrated paper-bound book (127 illustrations in 110 text pages) on the construction and use of wire ropes is clearly set out and indexed, and carries a 23-item bibliographical note. Testing and corrosion prevention are treated at some length.

Testing of Glass Volumetric Apparatus. By J. C. HUGHES. US National Bureau of Standards Circular 602. *Superintendent of Documents, US Government Printing Office, Washington 25, D.C.* (*20 cents*)

This brochure brings up to date the specifications for glass volumetric apparatus of precision grade. Test methods are described, specifications for newly developed items have been added, and consideration is given to new manufacturing methods as they affect test specifications.

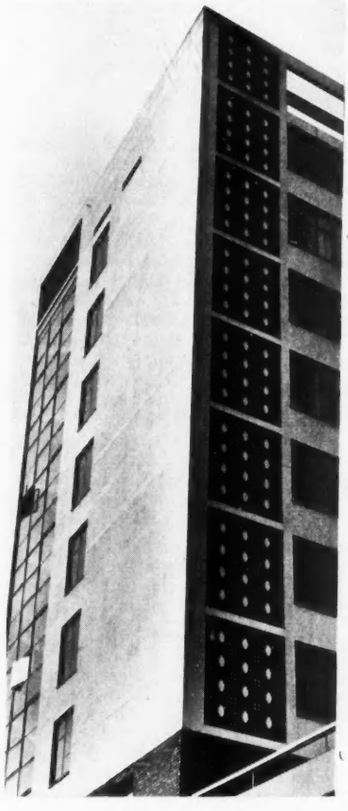
New Materials for Modern Buildings

It would not be very imaginative to use mud as a building material in modern architecture, yet many voices have been raised against the use of such newcomers as plastics in building. Is it to be "find the best of the new", or "cling to the old"? Here is a selection from the recent Building Exhibition.

Mosaics and Polka Dots

Until the recent craze for mosaics, most people probably thought of them as belonging to the bygone days of Friends, Romans and Countrymen, and certain later movements in Italy. Mosaics were, in fact, used primarily in Italy up till the 14th century, but in India in the 17th century, fine marble inlays were also applied on a number of Mohammedan buildings, a style now called Florentine.

Snowtop and their associate company, Mosaic and Terrazzo Precast, have recently introduced the following products: Terrazzo Polka-Dot tiles; these are standard size tiles having a pattern of polka-dots of varying size inserted in the surface. Snowtop Kervit tiles, which are ceramic wall tiles manufactured by Ceramica Veggia and are guaranteed not to craze, even



Mosaic cladding on the new Villiers House in the Strand.

when heated to 365° F and immersed in ice cold water; Duratiles—these are industrial tiles which employ a flint aggregate. They are immensely tough yet have an "attractive appearance" approaching a terrazzo finish; and finally, Snowtop Spanish tiles, which have a new "windswept" appearance, whatever that means.

From tiles to mosaics; these companies also showed the latest range of Italian glass and ceramic mosaics most of which are new to the UK. Dennis M. Williams have also been very active in this field, and the illustration, showing one aspect of the new Villiers House in the Strand, is one of their large undertakings, this time with the architects Messrs. Trehearne, Norman and Preston. This firm, Dennis M. Williams, have had a hand in both cladding and mural work with mosaics, and into the last category falls the work undertaken with Mr. John Piper for the new church at Harlow, and the BBC television centre. Mosaics for this firm come from Sweden, Italy and Czechoslovakia.

Snowtop Products Limited, Ashford Road, Ashford Common, Middlesex.
Dennis M. Williams Limited, 43 Thames Street, Kingston-on-Thames, Surrey.

PVA Building Adhesive Can Improve Concrete

A "Universal Building" adhesive based on pva has been marketed for a number of years by a company now called Polybond. As the "Universal" implies, it is versatile. It is, in fact, useful both as an adhesive, and as a strengthening additive to standard cement mixes.

Thus, it will bond to almost any material including stone, concrete, granite, glass and metal. It can be diluted with water to make it thinner and more penetrating, and has been used for giving body to old plaster. Hessian and Polybond satisfactorily restored the old plaster in vaults of Hereford cathedral.

Addition to standard cement mixes produces concrete having increased tensile strength, and wear and water resistance. The adherence of the pva content assures good sticking of cement and plaster to smooth surfaces. In the Royal Southampton Hospital—scene: the plaster room—the procedure for recoating a smooth granolithic floor was as follows: first apply concentrated Polybond to the old floor; then apply a second coat, 50 water-50 adhesive; lastly apply a gauging coat of one part sand, one part cement, wetted with a mixture of equal parts of adhesive and water. This is satisfactorily standing up to frequent washing, and scraping both from metal bedlegs, and from the scraper for removing plaster from the floor.

Polybond Limited, 16 Gloucester Place, London, W1.

Lightweight Aggregates Old and New

A process which is widely used in the United States will be employed by Stanton Ironworks to make lightweight aggregate. Production will begin in early 1960 with a capacity of 100,000 tons a year. In this Kinney-Osborne process, jets of steam and air are passed through the molten slag as it leaves a furnace. Subsequently it is cooled with water. Compared with other slag foaming processes, notably pouring molten slag into a water bath, this offers closer regulation of density and pore size.

These lightweight aggregates may be used for cement—in which it is crushed to a fine powder weighing 20 lb per cu. ft—or may be incorporated in lightweight cement generally, and such components are precast flooring blocks. For these last applications there will be three grades: $\frac{5}{8}$-$\frac{3}{8}$ in and $\frac{3}{8}$-$\frac{3}{16}$ in at 33 lb per cu. ft, and $\frac{3}{16}$ in down, at 37 lb per cu. ft.

Laing's Lytag was mentioned in this journal on 13 November '59, p. 475. It is an aggregate containing 60 per cent air and 40 per cent pulverised fuel ash, which has been sintered and broken up into particle sizes from $\frac{5}{8}$ in to fine sand. In spherical form the bulk density is 40 lb per cu. ft, when crushed, 57. Laing's add, "most dense aggregates are far stronger than they need be"; Lytag is quite satisfactory for making concrete with compressive strengths up to 4,500 lb per sq. in, which covers most structural uses. Laing's have launched the manufacturing concern as a new company which gives its name to the aggregate.

Butterley's Aglite is now getting quite long in the tooth, having been made since 1956. This is an expanded clay product made on a horizontal sinter hearth, and comes in similar grades to the new Stanton product. The density is about the same. Aglite has now been used extensively in practically all forms of building construction, including what is believed to be the first frame structure in this country incorporating lightweight aggregate. Thermal insulation of such concretes is more than double that of dense concrete.

The Stanton Ironworks Company Limited, PO Box 3, Nottingham.
Lytag Limited, Manor Way, Boreham Wood, Hertfordshire.
The Butterley Company Limited, Ripley, near Derby.

Reinforced Concrete Glazing Unit

Made of concrete only, this glazing unit has nothing to rust or require maintenance. Atlas Stone Company describe it as having "fine appearance," and opinion on this may be the deciding factor as to whether or not it is taken up in this country. In Belgium, Germany and France, it has been widely used already.

This glazing unit comes in three sizes, for 8·6, 4·3 and 3·2 units to the sq. yd. They are factory made, and absence of faults is assured by combination of ultra-high frequency vibration with high pressure moulding. As shown in the section, conventional round mild steel reinforcement is provided in the joint between adjacent frames, so that the structural entity can withstand quite severe wind loads. Resistance to extreme weather, is, in fact, one of its main

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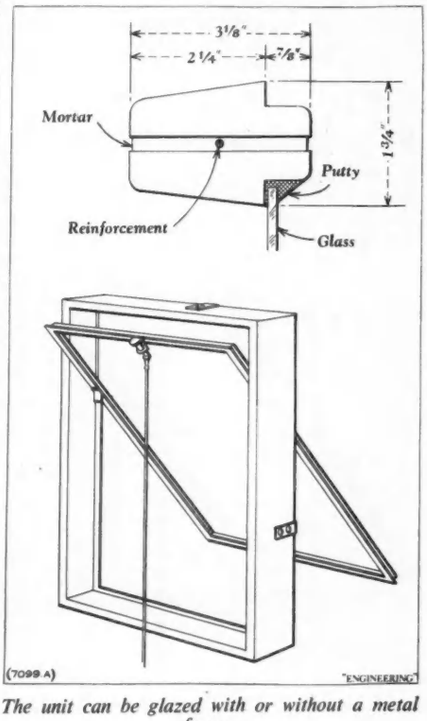


The unit can be glazed with or without a metal frame.

selling points. The other, perhaps, is low cost.

Maintenance need be non-existent since the only components are concrete, putty and glass. The rebate is said to be of sufficient depth to allow for use of double glazing, and as yet another alternative, there is an optional, heavily galvanised frame for the larger sizes with a horizontally pivoted window.

The Atlas Stone Company Limited, Westminster, London, SW1.

Plastic Faced Insulation

An asbestos insulation board made by Cape Building Products has been given a facelift by predecorating it with a polyester coating. This is intended for internal surfaces " where permanent decoration or a high standard of cleanliness, moisture resistance or corrosion resistance is required."

The plastic coating is 0·006 to 0·008 in thick and comes in a range of Munsell References, or in other words, colours. This begins to soften at about 250° F, and can be nailed or drilled, sawn and bevelled, while at room temperature the scratch resistance of the polyester coating is good.

Cape Building Products Limited, Cowley Bridge Works, Uxbridge, Middlesex.

Decorative Wood/Plastic Laminate

It is not quite so easy to make a laminate of wood with a plastic facing as one might think. The difficulty is the difference in shrinkage and expansion. One solution to this has been incorporated in a recently launched American laminate, and consists of V-groove breaks in the plastic covering every 16 in. This is on a total thickness of $\frac{1}{4}$ in. In the United Kingdom, Formica have come up with a different answer, which is to make the wood thick, $\frac{5}{8}$ in, and to choose one which has the same expansion characteristics as the plastic.

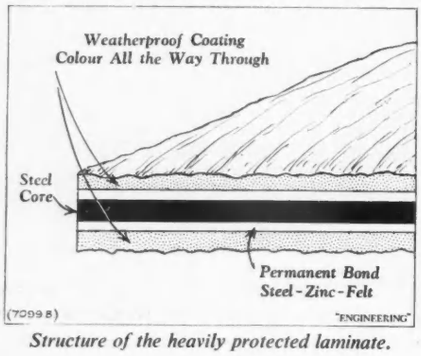
The result is a laminate which is dimensionally stable and which can be used for large wall panels without fear or warpage. The overall density of the composite $\frac{5}{8}$ in laminate is just under 2 lb per sq. ft which is said to be as low as any on the market. When the £500,000 extension to the Formica factory goes into production of the Beautyboard, the product will be sheets measuring 9 ft by 4 ft and 8 ft by 4 ft. Supplies to the retail market are not expected until early 1960.

Formica Limited, 84 Regent Street, London, W1.

Steel/Zinc/Asbestos/Paint

The Robertson range of Colour Galbestos introduced just over a year ago has been extended to include a number of pastel shades, including green, grey, red and blue.

The construction of this laminate is rather unusual, as is shown in the diagram. In manufacture the steel core sheet is given a zinc coating. This is itself a protective layer, though in this product its primary function is that of an adhesive. While the zinc is in a molten state, asbestos felt is pressed on to it, squeezing the fibres of the felt into the zinc. The protective asbestos felt layer is impregnated with liquid bitumen, and finally a tough, thick, weather and corrosion resistant coating is applied to the sheet. One could defy it to corrode after all that.



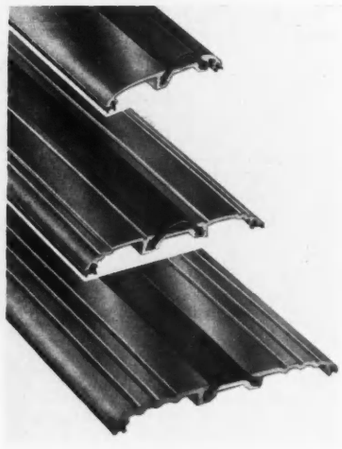
Structure of the heavily protected laminate.

Its prime use is for the cladding of walls and roofs of buildings, but it can also be used for manufacture of ventilators and flashings where these are visibly featured.

Robertson Thain Limited, Ellesmere Port, Wirral, Cheshire.

No Tripping Over This Threshold

If you have: draughts which blow; dust which seeps; insects which creep; or sound which escapes, then the answer may lie in one of the Duraflex thresholds—that is, if the trouble is taking place under a door. Should the undertaking be an industrial one, then there are two specially large, strong models which have been recently introduced to choose from. These thresholds are made from an extruded aluminium alloy into which is fitted a flexible vinyl plastic strip. It is this plastic which provides a tight seal against the bottom of the door. The three sections, the smallest being for domestic consumption, are as shown in the diagram. The largest is 6 in wide, the next 5 in, and the last $3\frac{1}{2}$ in. All that is needed are a few screws and the determination to saw the odd inch off the bottom of the door.



Two larger sections are for industrial use.

Duraflex Housecrafts Limited, Carpenter Street, Manchester 1.

Scintillating Stone Facings

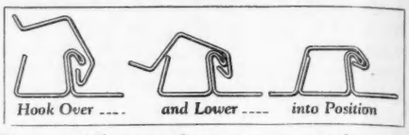
Glamorock have been busy developing new forms of natural stone facing paints, and have introduced two products at the exhibition. The colour in Glamorock Granite Decor is derived from natural crushed stone, as it is in all the products. It comes in the form of a thick paste and must be mixed with water into paint-like consistency before being applied by brush or gravity-feed spray gun.

The latest product of this company is a one coat natural stone facing called Glamorock Colorplaster, which has many uses in the home, such as for fireplaces, window sills and bathrooms; especially suitable for the slap-it-on, do-it-yourself merchants. This product is a one coat form of the original stone wall-facing and comes in 14 colours with one aggregate only. Its parent material, just mentioned, comes in a range of 22 natural colours and has a choice of two aggregates.

Glamorock Limited, Monza Street, London, E1.

Interlocking Aluminium Roof

Lokroll roofing sheet was introduced by the British Aluminium Company at the exhibition. It has been developed to provide a fully-supported roof similar to the traditional batten roll, and capable of rapid erection as shown in the diagram. Each sheet locks automatically to the next, forming a weatherproof joint even at minimum pitch.



These rapidly erected sections are weatherproof.

Standard width of the section is 12 in, and it can be obtained in lengths up to 40 ft. Two types are made, the first, coded 12, can be used fully supported, the second, 6, for fixing to purlins.

British Aluminium Company Limited, Norfolk House, St. James's Square, London, SW1.

Chipboard is Longer

Entombed in a stand made from their own product, British Plimber showed at the exhibition just what can be done with their chipboard. The strength, wear resistance and water resistance of Plimber 45 make it useful for heavy-duty applications such as industrial flooring—suspended or solid—racking on slotted angle for engineer's stores, concrete formwork above and below the ground, and other load-bearing purposes.

Hot from the press: Plimber 45 can be had in 4 ft widths in any length up to 16 ft.

British Plimber Limited, Rainham, Essex.

Flame Retardant Paint

If ever your building begins to catch on fire, you can count yourself a wise man if the fibre insulation boards have been pretreated with a flame retardant paint. One of those on the market is called Trerock. It raises the board to class 1 surface when tested for surface spread of flame in accordance with BS476:1953. Part 1. This is the standard of resistance to the spread of flame prescribed in the regulations made under the Thermal Insulation (Industrial Buildings) Act, 1957. Separate pretreatment of the board is, therefore, unnecessary.

The paint comes in 20 modern decorative shades and dries with a smooth matt decorative finish which the makers describe as " pleasing " —that is, unless the user was looking for a gloss finish. The paint can be subsequently redecorated, is non-toxic and non-corrosive.

Pearl Varnish Company Limited, Treforest Trading Estate, Pontypridd, Glamorgan.

Multicolour Painting in one Operation

It may sound odd that a single paint consisting of fluid sacs of varied colours can be sprayed through a gun to give a multicolour surface, but this can now be done. The product, perhaps not surprisingly, is called Multicolour, and is made by Tretol. In the past, this company says, many attempts have been made to achieve the multicolour flecks which make a surface of stone so attractive. Results have, up till recently, been indifferently successful owing to the excessive number of operations involved, with consequent uneconomic costs.

The fluid sacs, of one, two or more colours, are suspended in the basic background pigment, and these retain their identity until being sprayed, when they create an interlocking network of colour. The size of the " aggregates " can be controlled in manufacture.

Tretol Limited, The Hyde, London, NW9.

Mobile Axial Water Pump has Fast Delivery

A pump that can deliver large quantities of water quickly is essential for farmers and planters. A mobile axial pump that is particularly suitable for flood control and drainage is described here.

The Maxiflow pump, developed by the Armfield Hydraulic Engineering Company Limited, Ringwood, Hants, has been designed for flood irrigation and for filling reservoirs or "turkey-nest" dams. The unit can be supplied in trailer form or for rigid mounting on the river bank. The drive can be by agricultural tractor, stationary diesel engine, electric motor or belt connected to a suitable prime mover.

The 10 in Maxiflow pump consists of a propeller mounted inside a tube. High efficiency results from careful design of the propeller and straightener blades, based on recent research work on aerofoils. A coarse strainer is fitted to the intake, to protect the pump and pipeline from stones and deadwood that may be sucked through the inlet pipe. The pump can, however, deal with small debris without damage or loss in performance. The complete suction pipe is fitted with a "quick release" device so that it can be easily removed if the strainer does get clogged with weeds. With this pipe removed, the impeller is accessible for inspection and cleaning.

The most useful performance is obtained at impeller speeds between 1,350 and 1,750 r.p.m. These are, however, greater than the maximum speed of the "power take-off" (p.t.o.) on most tractors and the pump can therefore be obtained with a speed-increasing gearbox. This is of the oil bath, totally-enclosed type, fitted throughout with ball bearings. The gears have a ratio of 1 to 2·7 increasing and a tractor with a maximum continuous p.t.o. speed of 540 r.p.m. (such as the Ferguson TEF20) will drive the pump impeller at a speed of 1,460 r.p.m. A tractor with a maximum p.t.o. speed of 630 r.p.m. (for example, the Ferguson 35 or Fordson Major) will drive the pump impeller at a shaft speed of 1,700 r.p.m.

Power take-off speeds and corresponding impeller speeds, based on the standard gear ratio of 1 to 2·7, are:

Speed (r.p.m.)	650	630	590	540	500
Impeller speed (r.p.m.) ..	1,750	1,700	1,600	1,460	1,350

The Maxiflow pump is also available with a universal gearbox giving a 1 to 1 ratio as well as the 1 to 2·7 increasing ratio, for both clockwise and anti-clockwise rotation. With this arrangement, the pump should be mounted on the river bank, and driven by a tractor, diesel engine, foot-mounted electric motor or other suitable prime mover. It is necessary to couple the pump to a separate bearing-mounted jack-shaft when driving it by belt. Every pump can be supplied with a Hardy Spicer type flexible drive on the jack-shaft. When electrical power is available the pump with flange-mounted motor is recommended. Motors for 50 or 60 cycles are available and there is a choice between a totally-enclosed or a drip-proof motor. The 10 in pump is made in several types.

PERFORMANCE

Assume that it is desired to fill a reservoir situated 7 ft above the river level through 100 ft of 8 in pipe at a rate of 2,000 gallons per min. From the top set of curves in Fig. 3, showing the friction losses in the pipe, 2,000 gallons per min through an 8 in pipe corresponds to a head loss of 11½ ft (point A). It is necessary, therefore, to pump against a total head of 18½ ft (7 ft static head plus 11½ ft friction head). On the middle set of curves showing pump performance, for an impeller speed of 1,460 r.p.m. (540 r.p.m. on the tractor p.t.o.), the pump will deliver 2,000 gallons per min against a head of 18½ ft (point B). From the lower set of curves, the power absorbed can be checked; in this particular case it shows that 15 b.h.p. is enough (point C).

The 10 in Maxiflow flood irrigation pump will, in fact, deliver up to 150,000 gallons per hour against a head of 22 ft and requires 22 b.h.p. only. It will raise the level of water in a reservoir covering 1 acre by 1 ft in less than 2 hours.

There are several types of Maxiflow pump. Type 1 is a trailer unit specially developed for operation with tractors or other vehicles with a p.t.o. shaft having a speed range of 500 to 650 r.p.m. It is best suited for sites where a mobile unit is essential. (Figs. 1 and 2.) The type 2 trailer unit is similar to type 1 without the speed-increasing gearbox. The drive ratio, therefore, is 1 to 1 and the pump is at its best when coupled to a mobile diesel unit, a Land Rover fitted with a rear power take off, or any high speed engine (1,350 to 1,750 r.p.m.). Type 3 has been designed for permanent mounting in a vertical position. The pump is driven through a universal gearbox with a bevel gear having a 1 to 1 ratio and a spur gear with a 1 to 2·7 increasing ratio. Thus it is possible to drive the pump by farm tractor, diesel engine, Land Rover, electric motor or steam engine. Furthermore, the addition of a jockey-shaft makes the unit suitable for any type of belt or chain drive. The outlet can be in one of eight different positions, so as to make the best use of the site layout. The pump is mounted securely once and for all to the river bank, but the driving engine can be removed and used elsewhere when the pump is not in use. The type 4 pump is directly coupled to a flange-mounted electric motor, wound for either 50 or 60 cycles. In the first instance it operates at 1,460 r.p.m., and in the second the shaft speed is 1,750 r.p.m. This unit is clearly best for a site where electrical power is available. The outlet can be positioned at an angle to suit the site.

In applying aerodynamic theory to the design of a propeller pump, various simplifying assumptions have to be made. It was assumed in the design of the Maxiflow pump that the actual blade was replaced by a series of aerofoil sections, each layer being independent of the next. An aerofoil of any arbitrary shape will experience a lifting force when suitably placed in a velocity field, and if this force can be predicted, the pressure developed can be calculated.

For free-vortex-blading, constant efficiency and constant head are assumed for all sections. This is to preserve radial-pressure equilibrium. The theory is a combination of momentum "actuator disc" theory and blade element theory. Calculations were made to determine the blade angle and chord length at ¼ in intervals across the 2½ in blade. Between these successive radii, the blade was smoothly graded so that there were no abrupt changes in geometry. The calculated blade efficiency at design flow varied between 93 and 97 per cent from tip to hub. This was because the lift coefficient chosen for the tip was smaller than at the hub, and consequently the drag/lift ratio, on which the blade efficiency mainly depends, was greater.

The aerofoil section used was an RAF 6, Section E. It has good performance characteristics and the flat undersurface eases manufacture. The straightener blades, six in number, were designed with a constant chord length. A thinner section, complying with NACA specification 6306, was chosen for these blades.

Fig. 1 (above) and Fig. 2 (above right) show the 10 in trailer unit, type 1, specially developed for use with tractors or other vehicles having a power take-off shaft speed range of 500 to 600 r.p.m.

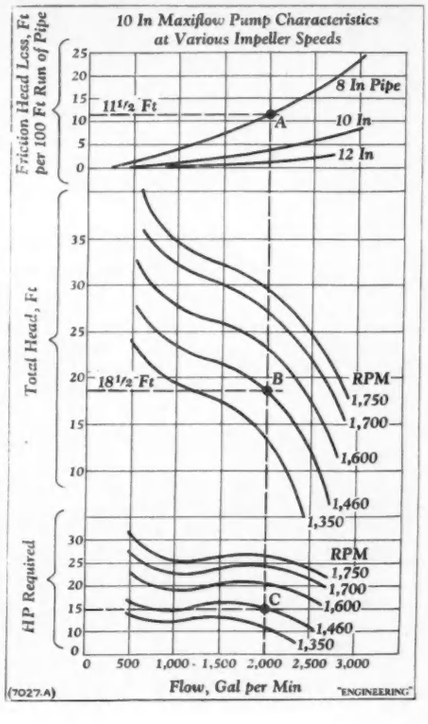


Fig. 3 (lower right) The top set of curves show the friction head loss, the middle set the total head and the lower set the power absorbed, plotted against flow.

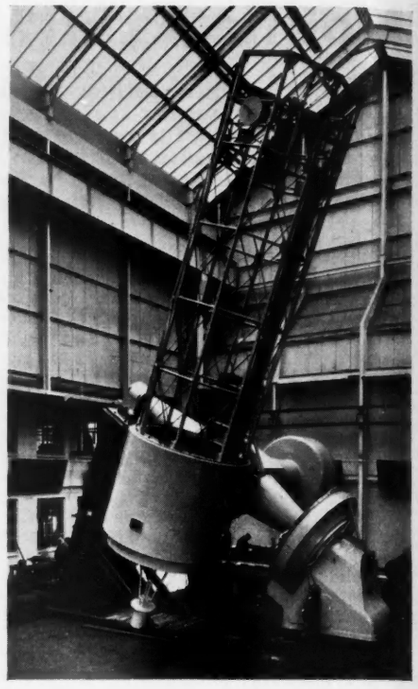
Reflecting Telescope for Japan

This 74 in reflecting telescope is to be erected at the top of 1,200 ft Mount Chikurin near Kamogata in the Okayama prefecture, about 500 miles southwest of Tokyo. It will be the largest telescope in Asia. The Observatory, a new one, will be a branch of the Tokyo Astronomical Observatory with the name Okayama Astrophysical Observatory.

The telescope, which was ordered in 1955 from Sir Howard Grubb Parsons (a subsidiary of C. A. Parsons and Company Limited, Newcastle upon Tyne, 6) has now passed its final tests in the maker's works at Newcastle upon Tyne, and will be despatched early in 1960, four months ahead of the original delivery promise. The illustration shows the telescope undergoing tests. The main optical component of the telescope is the parabolic mirror which collects light from distant stars and focuses it, either on to a photographic plate or on to the slit of a spectrograph. The mirror is a disc of low expansion glass of 74 in diameter and about 11 in thick, with its front surface ground and polished to a concave parabolic form, accurate all over to about 2 millionths of an inch. This piece of glass weighs more than 1½ ton and the surface was ground and polished in the optical department of the company, as were the five smaller subsidiary mirrors in the telescope.

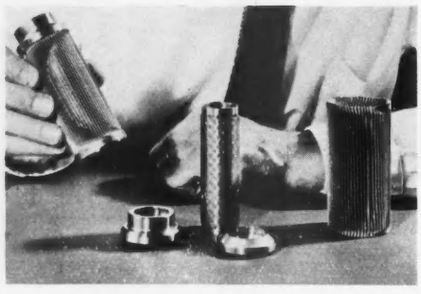
The mounting and mechanism required to move it, were all designed and made by the same firm. The 50 tons of moving parts can be directed to any desired section of the heavens by push-button electrical control systems. Some idea of the precision of an instrument of this type can be gained by bearing in mind that a star image formed on the photographic plate will be of no more than 0·001 in diameter, and this image produced by reflection in the large mirror must be held steady on the photographic plate to less than a thousandth of an inch. To do this the whole telescope must be pointed at the moving star with an accuracy of less than a second of arc for some hours. This is equivalent to a pointing accuracy of the diameter of an orange 20 miles away.

For transportation to Japan, the telescope will be dismantled into some six or seven major sections and packed in 47 crates of various sizes up to 23 ft by 9 ft by 9 ft. Its assembly on site will be supervised by engineers from the maker's works, sent out to Japan for the purpose. When this work is completed, Grubb Parsons will have installed a 74 in reflecting telescope on each of the five continents, America, Africa, Australia, Europe and now Asia.



Pressure-locked Filters

Lightweight filters free of built-in contamination, with the elements locked together mechanically by a specially-developed high pressure process, have been developed by Purolator Products, Inc., Rahway, New Jersey, USA.



The high pressure process, using special dovetailed construction, locks together all the components of the filter element so securely that the filter medium is embedded in the parent metal of the end caps to form a leak-proof seal. Since the process requires no welding, aluminium and dissimilar metals can be used in filter design.

These pressure-locked filters are now in production with stainless steel wire mesh elements, ranging in diameter from 1 in to 1¾ in.

Filter assembly and manufacturing processes used up to now have required bonding agents (welding, brazing, or other cementing materials) which reduce or destroy the inherent cleanliness and operational characteristics of the metals used. With the new process, the fine wire mesh is not subjected to the high temperatures produced in welding or brazing and so is not contaminated by oxidation products, nor is the stainless steel heated to the zone of carbide precipitation.

This pressure-locked process, which can use dissimilar, but lighter, metals, cuts filter weight nearly in half. For example, if aluminium were used for the end caps and centre tube, a pressure-locked standard 12 g.p.m. aircraft hydraulic filter element of stainless steel wire mesh would weigh 0·45 lb and not 0·79 lb for the same size unit made by conventional methods requiring all steel parts: a weight saving of 43 per cent. High pressure mechanical locking increases the available element filtering area by eliminating wicking due to brazing or cementing. This proportional area lost is of less importance in large size filter units, but becomes increasingly significant as the size of the element decreases.

Present ratings are for a nominal 10 micron (absolute maximum particle size of 25 micron) and for a nominal 5 micron (absolute maximum particle size of 15 microns) in capacities of ½, 3, 6 and 12 g.p.m.

Fire Engine Design with a Difference

The first fire engine design to be produced by Leyland Motors Limited, Leyland, Lancs., since they re-entered this field after a period of 20 years, was recently demonstrated (in collaboration with Lieut. Cdr. K. N. Hoare, Chief Officer at Manchester City's Fire Brigade Headquarters) before fire officers of some twenty brigades in the North West.

The new engine, the Leyland Firemaster, is very different from any other design so far produced. It is a diesel-engined dual-purpose appliance, with the engine mounted amidship below the frame and the pump mounted at the front.

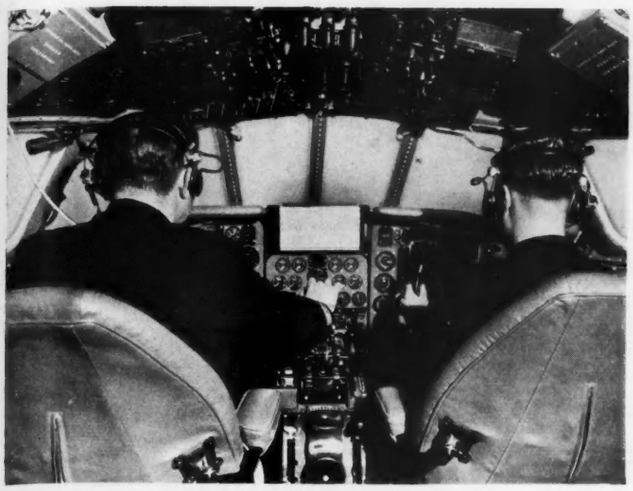
The diesel engine was chosen, not only because of its reliability and excellent cold starting characteristics, but because, as compared with a petrol engine, it gives its power at low speeds. The engine is located below frame level to allow complete freedom in body design and to give a low centre of gravity for the machine. This also allows front positioning of the pump, with the pump intake and outlet at the front, a position which seems to be generally popular with city brigades since it allows the appliance to be driven straight up to the water supply.

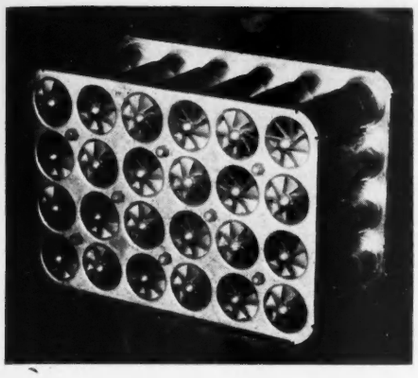
The chassis has only two driving pedals (a brake and accelerator); a two-speed rear axle, with an electric gear shift providing eight forward speeds; and pumping controls located at the front of the vehicle. To make room for the controls the radiator has been put on one side of the frame near the rear wheels.

The demonstration started with high pressure hose reel tests. At 500 lb per sq. in pump pressure, water was delivered through one spray gun (15 g.p.m.) and one spray applicator (6 g.p.m.), first from the first aid tank, giving approximately 5 min. supply, and then from a hydrant. In the second demonstration between 1,150 and 1,200 gallons per min. of water were pumped through a 6 in dia. pipe to a height of 70 ft at a pump pressure of 55 lb per sq. in. Then, two 1 in diameter jets located 110 ft up on the hose tower were supplied, an output of 370 to 380 g.p.m. at a nozzle pressure of 60 lb per sq. in being obtained with a 120 lb per sq. in. pump pressure.

A remote-control monitor, produced by Knowsley Cast Metal Company Limited, was then used to show the potential of the engine with this type of apparatus. Somewhat resembling a small gun turret, with a 2 in nozzle instead of a gun, it rotated and elevated the nozzle from a remote control to shoot 850 g.p.m. of water to a considerable distance. After the pumping tests the handling of the fire engine complete with wheeled escape was demonstrated.

A power transfer box at the front of the engine provides a step up ratio of 2 to 1 to drive the main pump and hose reel pump at the front of the chassis. The controls for engaging both pumps are situated on the pump panel at the front of the appliance.





(Top left) Interior of the cockpit of the BEA Comet flight simulator at Heston, designed by General Precision Systems Ltd.

(Top right) Sikorsky S-60 crane helicopter transporting a rocket. It carries its load externally and so does not have a cabin.

(Left) Air filter designed by the Fighting Vehicles Research and Development Establishment for use with multi-fuel engines.

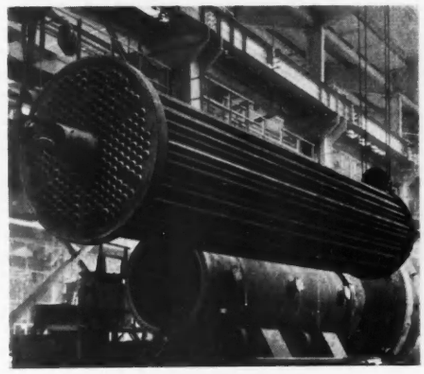
(Right) Sound control desk type 4554, developed by Marconi's Wireless Telegraph Co. Ltd. at the transmitting station of Radio Ankara.

(Left) Postal vending suite designed by Associated Automation Ltd. for use in the United States.

(Right) Tube bundle designed by P.G. Engineering Ltd. ready for sleeving in the shell of a waste heat boiler.

(Lower left) Top dome and thermal shield of No. 1 reactor at Bradwell, designed by the Nuclear Power Plant Co. Ltd.

(Lower right) The Palazzetto dello Sport, one of the buildings for the Olympic Games in Rome next year.

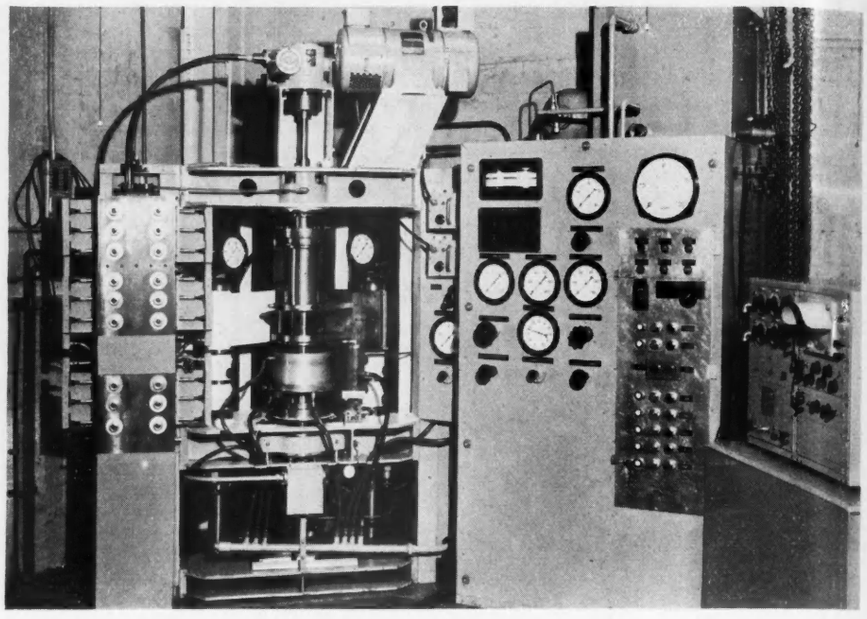


Lubricating System Increases Bearing Capacity

A research group at the Glacier Metal Company Limited, Wembley, Middlesex, has shown, with the aid of a series of test rigs, that conventional methods for lubricating the bearings of internal combustion engines fall short of theoretical expectations. The group has invented a new means of lubrication which they call Ramrod. This will enable bearings to be shorter, crankshafts stiffer and engine speeds greater, so that more power will be possible from a given engine frame.

One of these test rigs can simulate the loads imposed on the crankshaft bearings of a four or two stroke oil engine. Because the bearing material in the rig is transparent, the behaviour of the oil film inside the bearing can be observed directly, as shown. To load the bearing realistically, pressure is put on it in one plane by one cylinder; another cylinder at right angles applies transverse loads. The pressure in these cylinders is varied by cam mechanisms coupled to the main shaft. These cams can be set to reproduce in the "lab" any polar load diagram that an engine would generate in everyday performance. These diagrams can be shown on an oscilloscope screen.

In order to see what happens to the oil film, the shaft has to run very slowly (at only 7 r.p.m. in this case) and for realism the bearing load, the oil viscosity and the inlet oil pressures are all adjusted. Thus, to match the speed reduction of 1/70th, the oil pressure and loads on the bearing are decreased to 1/14th of reality but the oil viscosity is increased five times. By this means, the whole set up runs under dynamically similar conditions to those typical of a big-end bearing running in an engine. On the firing stroke, pressure drives the cap half of the bearing away from the shaft, and the oil film collapses due to cavitation. This may seem to be of little consequence, since the load is borne by the top half of the rod, but unfortunately this area of cavitation *rotates*, at about half the shaft speed and so, in due course, turns up on the pressure side. Thus, on the rod side, the bearing material receives the full force of the explosion at a time when only a fraction of its area is protected by the oil film which is supposed to separate it from the crankshaft. This can be seen on the Glacier test rig. The cavitation comes round into the rod half before the firing load, helped on its way by the fact that, at this moment, the inertia forces may be greater than the compression forces, thereby increasing the clearance between the rotating parts on the rod side. This leads to a well-known type of bearing failure that is typical of incomplete lubrication (typical, that is, of cavitation) which can defeat the best efforts of an engineer, even when he gives the engine an adequate oil pump and generous oil way areas through the crank shaft.



General view of the bearing oil film analyser.

Watching the shaft (in the test rig) as it simulates the real engine through the cycle of firing, exhaust, induction and compression, the disruption can be seen of the oil film prior to the firing point. Matters can, however, be somewhat improved by advancing the oil hole so that it lies 40° ahead of dead centre. (The conventional position is at top dead centre.) But another look through the Glacier simulator demonstrates that, even with the oil hole in the best position possible, there is still substantial cavitation. When once it has been seen what really goes on in big-end bearings, it is astonishing that they last as long as they do. They do not, of course, always last as long as desired, and it would be very agreeable if they could be subjected to even higher loads than they are, so that smaller engines could be built for a given power.

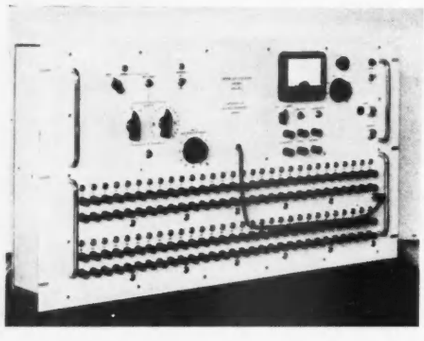
On an engine, running at 500 r.p.m., the Ramrod pump pressure would rise to about 900 lb per sq. in (it could be higher than this on smaller engines running at higher crankshaft speeds) but on the test rig it reaches only 65 lb per sq. in, for it has to match the other revaluations made to simulate reality when running at only 7 r.p.m. Every time Ramrod intervenes, the desert space caused by cavitation is filled with oil; what is particularly important, this always happens before the firing load. In other words, whereas, with an ordinary lubrication system, the surfaces lie nearly naked when the most severe test is applied to them, with Ramrod a complete oil film is invariably established before the thrust is applied.

The application of the system to the bearings of a two-stroke is also of immediate importance. In the conventional case, the two cycle bearing is in an even worse condition than the four stroke, because nearly all the cavitation in the cap half is carried round into the rod half for the next firing load. Even with the oil hole in its most favourable position (40° ahead of top dead centre) the cavitation occurs before each firing stroke. Not so with Ramrod.

Ramrod can be considered both as a relief and a stimulus. A relief because existing engine designs can have their bearing life extended many times without changing materials that have been used for many years. A stimulus because new designs, using high strength bearing materials, will be able to meet ever-increasing world competition with engines that, for a given power, are shorter, lighter and cheaper.

Thermocouple Selector for Data Sampling

The Allscott thermocouple selector is designed for applications requiring temperature measurements at a large number of points over a relatively long time cycle. It may be used in conjunction with a standard potentiometric chart recorder to plot in sequence and in groups of ten, temperatures at up to 60 points on a predetermined time cycle with a minimum scanning period of 10 min. Apart from the obvious economy because only one recorder is required, the method has the advantage that the full width of the recording chart is available for each measurement and there are no overlapping graphs to identify. This method of data sampling can also be employed with advantage in the measurement, remote indication and recording of other process variables, such as pressure, strain, displacement and so on. The Allscott—type 195 is illustrated—is made by James Scott and Company (Electrical Engineers) Limited, 68 Brockville Street, Glasgow, E2.



The chart record appears as a series of vertical temperature coordinates grouped for easy identification in sets of ten, while the time at which each measurement was made can be read off the chart in the usual way. A practical application of the selector arises in the stress-relieving of large welded steel structures by heat treatment. Careful control of heating and cooling (and, in particular, the avoidance of excessive temperature gradients during the cycle) is normally essential if the operation is to be properly carried out. Thus temperature measurements must be made at a number of points on the structure, so that any tendency for non-uniform heating may be corrected by re-distribution of the heating power. The twin-wire connections from each thermocouple junction are brought to numbered terminals on the front panel of the instrument. When switched to automatic scan each measuring point is connected in turn to the recording instrument by a system of relays and uni-selectors. These are so arranged that the recorder input is short-circuited, while the switches are changing over from one point to the next, so that the recorder pen always returns to the reference potential corresponding to an arbitrary known temperature between each measurement.

Radio Flying Squad Maintains Gas Supplies

In gas supply, as on the stage, the show must go on. To bring gasfitters to the scene of a fault at a moments notice is of paramount importance in an industrial area, and a radio control centre has recently been set up in Birmingham to direct the 24 hour maintenance service. To inaugurate the scheme, the Lord Mayor of Birmingham broadcast a test message asking for a service car to go to his private address. Four minutes later a telephone call back to the control room from his home announced that the van had arrived.

The Birmingham and District Division of the West Midlands Gas Board covers an area of approximately 235 square miles and supplies gas to some 400,000 consumers. Successive managements have appreciated the necessity for maintaining an efficient service organisation in order that the wide diversity of gas consumers can at all times be assured of an adequate and safe supply. Reliable operation is particularly important in an industrial area where many large consumers are working round the clock and breakdowns in production may be costly.

In the past, urgent requests for service have been answered by fully trained gasfitters reporting at intervals during the day to their respective depots. A number of fitters were also on continuous duty "out of business hours" thus completing a 24 hour service. Fully equipped motor vehicles were used to provide maximum mobility. Five years ago radio equipment was installed in the vehicles operating the service outside working hours. The success of this innovation led to the extension of "radio cover" throughout the whole 24 hours. In addition, the organisation has now been centralised at Lord Street to ensure a more efficient control and utilisation of the mobile units. Previously, all depots were responsible for dealing with requests for consumer service within their own district.

The new radio control centre operates 17 vehicles, each of which is in charge of a skilled gasfitter. They cover the whole area of the division. Each vehicle is equipped with the latest VHF radio telecommunication system, the base transmitter and receiver being sited at Lord Street. Two transmitting and receiving frequencies are used to avoid "queueing" on the air. The two antennae for transmitting and receiving signals are fixed to a 100 ft mast installed on the roof of the Lord Street building which is itself 50 ft high. The centre is manned day and night and the location of the mobile units is continuously plotted on large-scale maps. An average of 250 consumer service calls are dealt with each day, the great majority between 9 a.m. and 6 p.m. Such requests for service range from domestic consumers who have noticed a smell of gas at their cooker or meter, or whose supply of gas is not adequate, to industrial consumers who report escapes and deficiencies in supply. Close liaison is maintained with all mobile units so that they may be diverted to calls of higher priority.

When escapes of gas are located by service fitters as coming from a source outside the consumer's premises, radio communication enables the centre to communicate quickly with the distribution department and the main laying contractors so that these defects may be remedied without delay.

This extensive installation in Birmingham has been made possible by the combined efforts of the Radio Committee of the Nationalised Fuel and Power Industries in obtaining additional frequencies. Similar development is now taking place throughout the gas industry, and it is anticipated that there will be complete coverage over the whole of the country, including Scotland and Wales, within a period of about two years. The equipment which is in operation represents the most modern of its kind and is very much in advance of the normal GPO specification by having a bandwidth limited to only 25 kilocycles.

The Midlands Electricity Board have been engaged in a similar process of changeover and have assisted the West Midlands Gas Board very considerably by reorganising their programme so as to vacate the channel which the latter are now occupying in the 170 megacycle band. The old sets taken from Birmingham are being used to extend the coverage in the Stafford area and more sets are projected for Worcester which, probably by next year, will leave only Shropshire Division to cover before the West Midlands area has complete coverage.

Explosive Gas Detection

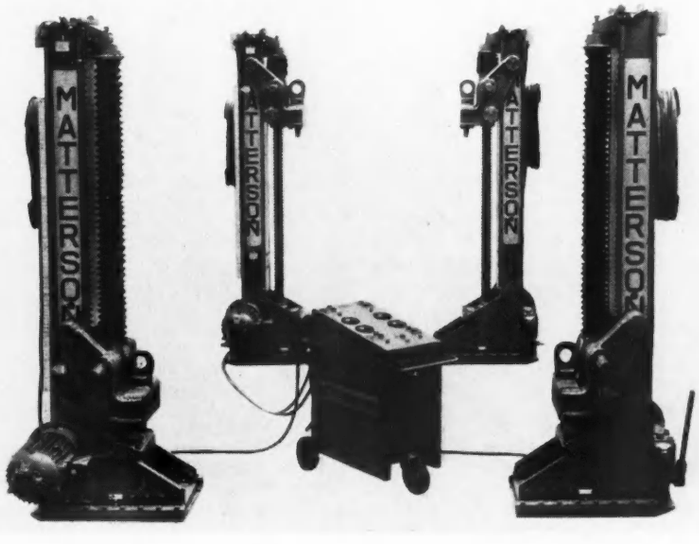
Dangerous concentration of inflammable gases may occur in many places. Some industrial situations are obvious sources of danger—mines, petroleum refineries and certain chemical factories, gas storage installations, laboratories and petrol engine test beds, for example—but there are also other places where the risk may not be so apparent at first sight. These include country houses, caravans and yachts using bottled gas for heating or lighting. To guard against these possible dangers, IEC-Sieger Limited, 39 Parliament Street, London, SW1, have introduced a new type of electronic gas detector, which is sensitive to all inflammable gases.

Consisting of a detector head which is mounted at the source of possible danger, and a control box connected to it by a flexible cable, the unit gives both visual and audible warning of the presence of gas, the warning continuing while the gas concentration persists. Special models can be provided to control shut-off valves and electric starters in addition to giving an alarm.

The detector operates by the catalytic method, using catalysts embedded in an insulating material, which is heated by wire coils forming part of a balanced circuit. Several catalysts are incorporated to make the detector sensitive to all inflammable gases. Reaction to gases by the catalysts increases the temperature and electrical resistance of the coils, causing unbalance of the system. This is transistor amplified to operate a relay and the alarm system. Ambient temperature and pressure changes have no effect.

Electric Screw Jacks for Locomotive Servicing

As part of the modernisation plan for Longsight locomotive depot, Manchester, British Railways have installed 20 ton electric screw jacks of a new type, made by Matterson Limited, Shawclough, Rochdale. These jacks are designed to raise a weight of 20 tons on a projecting pad to a height of 7 ft 1½ in from floor level, from a minimum height of 2 ft 3½ in. They are normally used in groups of 2, 3 or 4 and are controlled from a portable console type contactor box and control desk, to which they are connected by trailing wires. Each jack is controlled by a numbered switch selecting an individual contactor. A master switch energises the selected contactors simultaneously to move the jacks upwards or downwards as required.



Ammeters in each circuit indicate the load distribution among the jacks, and give warning of possible overload. The usual electrical overload protection is incorporated. Electrical limit switches cut out all the connected jacks whenever a single jack reaches the upper limit of travel, but the other jacks in the selected group can still be moved upwards after the one at its upper limit has been switched out. It is assumed that the jacks will not reach the lower limit when loaded, so the lower limit switch only cuts out the jack concerned; the others return to the bottom position if the master switch remains depressed.

A fabricated steel box houses the jack mechanism, and a flange-mounted 3 h.p. electric motor, driving the lifting screw through a worm and spur reduction gear, provides the jacking power. The lifting speed is 6 in per min under power, and a square shaft extension allows for manual operation in emergency. For transporting the jack, which has a base 24 in by 36 in and weighs 25 cwt, a hand-operated trolley with hydraulic lifting gear is available.

Honing and Automatic Transfer Lines

The honing process has developed rapidly during recent years and is now accepted as a finishing operation in the production of a multitude of parts. It enables substantial economies to be made in grinding and other pre-finishing processes and it also secures consistent accuracy and good surface finish even on a high production basis. One of its other commendable features is the facilitity it offers for incorporation into automatic transfer lines.

Economic considerations make it necessary to have reasonably large batch sizes in most production processes. The nature of the honing process, and the adjustability of the honing machine help to fulfil these requirements because it is often possible to employ a single type of machine for a variety of components.

There is, nevertheless, a discernable trend towards the automatic handling of smaller batches, and newly developed automatic honing machines are reported to provide a satisfactory and economic solution to this particular problem. If the machine is used as a separate unit it may be loaded by the operator tending the previous machining operation, the transfer and loading of the components then taking place within the machine itself. If the machine is to form part of a transfer line, the part may be taken automatically from the previous station.

The size and form of the component and also the accuracy required also control the loading method. When extremely accurate bores are necessary it is frequently more economical to employ only semi-automatic honing machines loaded by hand.

In all honing operations, automatic sizing is important. Only attachments which carry out this operation to an accuracy of 0·0001 in to 0·0002 in, and stop the machine immediately the required dimension is reached, make automatic honing possible.

The automatic honing machine has found a very large field of application in the motor industry, where the honing operation is now often included in automatic transfer machines. Several examples of the use of machines built by Nagel, G.m.b.H., of Nürtingen, Germany, are given below. Wickman Limited are the United Kingdom agents for Nagel machines.

Bevel gear bores are finish machined by a newly developed process on an automatic honing and gauging machine (Fig. 1). The highlight of this operation is centred upon the gauging and sorting of the component before it is machined. The parts are tipped into the magazine where a sorting plate aligns the bevel gears and carries them through a loading attachment into the fixtures on the rotary table. On the table the parts are first brought to the gauging station where the bores are gauged. Any component in which the bore is oversize is ejected. In position 2 the components with bores within the permissable tolerance are sorted.

Only components with undersize bores, which form some 20 per cent of all the components arriving at the machine, are automatically transferred to the honing station, where they are brought to size in floating locations. The honed parts are passed through the gauging station again, so that only components with the correct tolerance leave the machine. The output of this machine is approximately 8,000 bevel gears in 16 hours. The gauging time is 3 seconds, and the honing time 10 seconds.

As connecting rods are also produced in large numbers, the honing machine which deals with them has been highly automated. As shown in Fig. 2, the parts are honed on a machine with magazine loading, using a short stroking arrangement. Each connecting rod is honed separately. Coming from the previous operation, the components are loaded into the inclined magazine from where they are transferred automatically into the honing station. During the honing operation the components are allowed to float in their locations. The machine is controlled by an automatic sizing attachment, and a difference of up to 0·002 in of material removal has no influence as the sizing attachment only stops the machine when the finished dimension has been reached. The accuracy of the sizing attachment is between 0·0001 in to 0·0002 in.

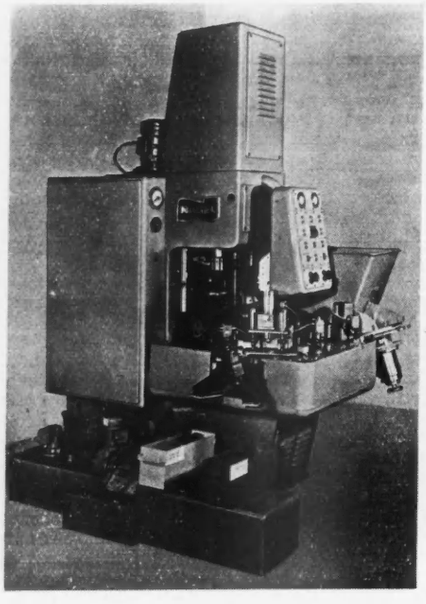


Fig. 1 An automatic honing and gauging machine used for finish machining bevel gear bores.

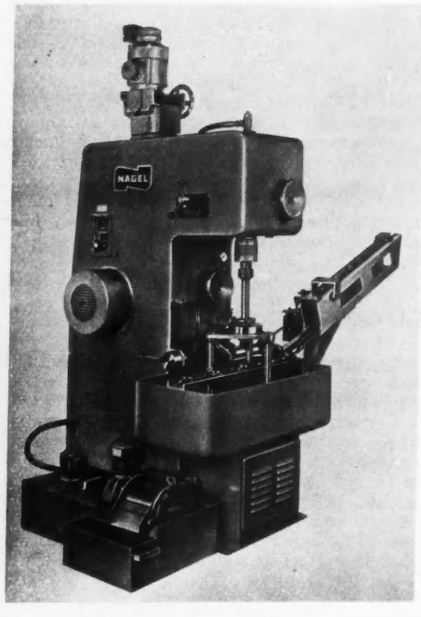


Fig. 2 A honing machine used to finish connecting rods.

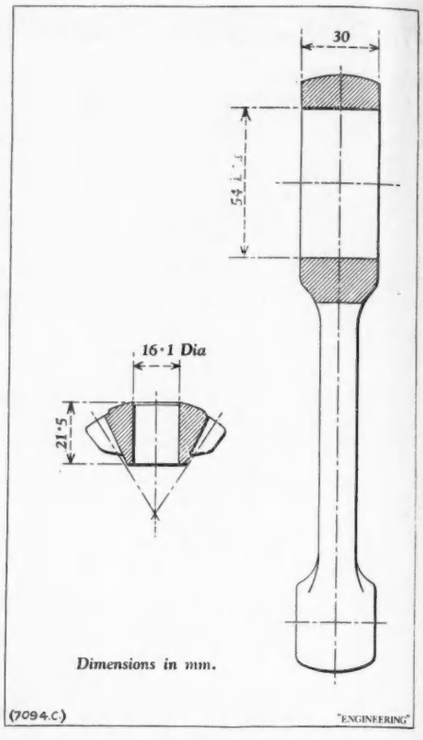


Fig. 3 The two parts, a bevel gear and a connecting rod, taken to illustrate the use of automatic honing machines.

Positional Control System

A new electronically controlled positioning system which can be used in conjunction with drills and other tools has been producing gas turbine components at the Derby factory of the Rolls-Royce Aero Engine Division. It is reported to give a high degree of accuracy without a skilled operator. The system, which has been developed by EMI Electronics Limited in collaboration with Optical Measuring Tools Limited, uses a 30 in rotary table. The system is controlled entirely by punched tape and has a setting accuracy of better than ± 3 seconds of arc.

The inductor measuring element of the system indicates the position of the table itself and not merely the position of the worm drive or lead screw, so the accuracy of the table is not affected by mechanical wear.

If several table settings are required, a programme of the angular settings is converted into punched tape, which is fed into a reader on the control console. For non-continuous operation, the operator presses the start button and the table moves to the first position, where it is automatically clamped, and the first machining operation is performed. The operator then presses the button to start another cycle of operations, and so on. For continuous operation, all movements are automatically controlled by punched tape. The operator only has to press the start button once and change tools later, if necessary. When making prototype or one-off components, a control tape is not required. When the table moves from one position to a second, it always rotates the shortest way round to the next position, either clockwise or anti-clockwise.

As well as using the positioning system for drilling holes in jet engine components, Rolls-Royce intend to apply it to milling machines for producing radial slots in aero-engine components.

Production

Sorting out Steel Specifications

Over the years a great many British Standards for steel have been published to meet the demands of industry. There are now more than 100 standards covering steel, and many of them contain within them several separate specifications for different grades of steel. One of the most widely used standards, BS 970, contains detailed specifications of over 100 wrought carbon and alloy steels for automobile and general engineering purposes.

A great many of the steels to these specifications, both in BS 970 and in other steel standards, differ from one another only very slightly, but nevertheless, because each is to be recognised as a British Standard grade, steel producers are expected to supply any and every type. This difficult state of affairs has come about for two main reasons. The first is that over the years, in the major steel-using industries, new types of steel have been specified somewhat haphazardly according to the requirements of the designers; these specifications, hallowed by time and tradition, have gradually found their way into the pages of British Standards. The second reason has been a tendency for BSI to publish separate steel standards for different groups of users such as the automobile, aircraft, chemical, petroleum, and locomotive industries.

There exists today in the steel industry a needless and uneconomic diversity of output which standards have not been able to control. It is therefore gratifying to report that BSI, with the collaboration of the steel industry and of important user interests, has taken the first big step towards ending this unsatisfactory state of affairs. This has been accomplished with the publication of BS 3141, the first part of Master Schedule of wrought steels. This first part is concerned with carbon steels. Further parts of the schedule will deal with (1) alloy steels with specified composition and (2) steels with specified mechanical properties but without detailed chemical composition.

In preparing part 1 of the new schedule, stock was taken of all existing British Standard specifications for carbon steel. Specifications whose chemical composition varied very slightly were arranged in groups. Then, for each group a compromise composition applicable to each specification in that group was agreed. Tests and mechanical properties, where appropriate, were also laid down. To avoid undue complication, only the main features of the steels have been indicated. An arbitrary system of classifying and numbering the steels has been devised.

To take an example: the new classification C2B1 brings together no less than seven existing specifications contained in five British Standards. Publication of the new schedule is not expected to bring about an overnight revolution in the way steel is specified. Its immediate result is that from now on, those concerned with drafting British Standards for steels will not be able to add to the existing welter of specifications without showing there is due justification for it. They will be required, for normal purposes, to choose a suitable specification from the master schedule. Thus confusion will be made no more confusing.

More important still, existing British Standards will gradually be revised so that the steels specified in their pages can be reclassified in accordance with the master schedule. The result of this big and complex exercise will be to reduce very substantially the number of steels now called for by industry. The long term result will be to rationalise and simplify British steel production, to permit concentration of output of fewer varieties of steel, thus raising productivity and ensuring better supplies of steel of the kinds most urgently required by industry.

Four Films on Productivity

The British Productivity Council ha e brought their number of films up to 29 by adding four new ones which had their first showing recently. The films deal with quality control, suggestion schemes, opportunities for boys at technical colleges, and the human factor in work study. They were produced by the council with the cooperation of industry, unions, educational bodies, and, in one case, of the European Productivity Agency of OEEC.

The first film shown was called " According to Specification." The 28 minute film takes the form of a discussion in an aircraft between the production director and the sales director of an industrial concern on the problems of maintaining a consistent quality standard for their product. Experience shows that conventional methods of increasing inspection between processes and of a full inspection of the final product are too costly. Another man in the aircraft, also an industrialist, suggests that it would be sounder policy to prevent defective products rather than to find them. In other words, quality control should be built into the manufacturing process. The argument is fully developed, and the theoretical and statistical aspects of quality control are further elaborated by a statistician who is also aboard the aeroplane.

The second of the films is called " People Have Ideas " and runs for 30 minutes. Again it is in the form of a discussion: this time between a television scriptwriter and his producer on suggestion schemes, which are due to form part of a television series on British Industry. The film develops the case for suggestion schemes from the point of view of both the people on the shop floor and of the management. It demonstrates, through case histories, the factors that make for a successful scheme, what snags may arise if care is not taken, and how they can be avoided. It emphasises throughout that good human relationships are the soundest basis for a good suggestion scheme.

" Training for Industry " is the title of the third film and it is intended primarily for boys in secondary school upper forms. It shows broadly the types of courses available at technical colleges, the qualifications to which they lead, and how, by taking courses at appropriate levels, boys can fit themselves into industry with enhanced prospects.

The film shows the careers of three young men, a craftsman, a technician and a technologist, in their firms and technical colleges. It emphasises the need for collaboration between firm and school. Particular emphasis is paid to sandwich courses and the Diploma in Technology. It embodies an indirect message to parents and teachers, designed to meet some of the prejudice against technical education.

The last film is "A Company of Men." It is about work study. Work study has been said to be 10 per cent technique and 90 per cent human relations. In previous films, the BPC has dealt with many of the technical aspects of the subject. This 30 minute film is designed to focus attention on the more delicate question of the prejudices and resistance which may be encountered at all levels when work study is introduced. It is presented not as a model application but as a realistic account of the difficulties experienced and eventually overcome.

Marketing

Cheaper and Better

Exhorted by the Chancellor of the Exchequer, quizzed by the Panorama show, industry continues quietly reducing the costs of some things and improving others at no extra cost.

Leyland Motors have done both together on the Albion Chieftain truck chassis, made by Albion Motors of Glasgow who are stepping up production to meet the demand. The new Chieftains have higher power at 94 b.h.p. and a new nitrided crankshaft, but they will be sold at £50 below the price of the previous Chieftains.

Leyland's have also announced that they have chalked up £300,000 worth of vehicle orders from Turkey since that market was reopened to automobile imports.

Nearer home, the Scottish Motor Show brought Albion Motors £375,000 worth of truck and bus chassis orders. Almost half of these orders were for the new Reiver range of six-wheeled truck chassis which has been introduced for a 15½ ton gross rating.

Getting the Bullet

One of the fastest making-and-selling stories comes from the Kleen-e-ze Brush Company of Bristol. Late last month the firm received a telephone call at eleven in the morning from consulting engineers to the Royal Dutch Navy in Amsterdam.

The navy had a ship out of commission and it needed boiler tube cleaning to get it back into service. An official, said the man on the telephone, was on his way by air to London for a supply of Kleen-e-ze's Bullet brushes which are fired through boiler tubes by a pressure gun.

The brushes would have to be specially made as the specification was for equipment above the normal size.

Production of the oversize Bullet brushes began and in the afternoon two members of the export division set off by road for London carrying 400 Bullets and a pressure gun, part of a much larger order.

By 7.45 p.m. the brushes and the gun had been handed to the Dutch representative who had been given a full explanation of the system. With his consignment of brushes the Dutchman set off back on the next available plane, taking to the ship in question a method already widely used in British power stations and by the armed services, wherever there are air or water lines.

Oxygen for Hong Kong

Hong Kong is a colony from which the news most often is of refugee problems. The British Oxygen (Hong Kong) Company brings a note of the industry on which, with commerce, Hong Kong depends, in its announcement that production of oxygen there is to be doubled in 1960 to meet the growing industrial demand. The ship-breaking industry is a heavy local user.

A new plant being supplied by British Oxygen Engineering Limited, of Edmonton, North London, another member of the British Oxygen group, will be shipped out to Hong Kong and will be of a larger capacity than the four existing plants in use there. Full production on the new schedule is expected by the second half of 1960.

Construction Rising

The non-housing work done for local authorities and on private industrial building is almost unchanged between the second and third quarters of the year. But there was an £11 million rise on the total for the third quarter over the second, due mainly to increasing work on housing by private developers.

The value of the third quarter's constructional work was £504 million, an increase of £40 million over the first quarter of the year. Against a trend often brought on by bad weather the

numbers employed by the construction industries rose from July to October by 16,000 to a total of 1,082,000 which is 15,000 better than at the same period last year. Costs are still slightly below the 1958 level.

1,288 Times Round the World

Calculations of the sort that demonstrate, for instance, that if all the teaspoons stolen from British Railways were laid end to end they would stretch from Euston to Glasgow are outdone by Sperry's figures showing that if the 51 lb rotor of their Mark 8 gyro compass, which has served the 8,406 ton M.V. Port Fairy for more than 30 years, had been running over the ground instead of turning on its bearings it would have travelled a distance equal to 1,288 times round the world.

Recent inspection of the gyro compass, installed in October, 1928, showed it to be accurate within a degree on any heading. For those who would like to check the figures the compass has been turning at its designed speed of 6,000 revolutions a minute, completing about 65,000 million revolutions if it is assumed that the Port Fairy, a Port Line ship, has been at sea for two thirds of her working life.

Capital Goods

A most welcome recovery has taken place in home orders for machine tools, which is at last tangible evidence that the engineering industry has resumed its capital investment programme. New home orders in August rose from £3·48 million to £4·03 million and the order book outstanding at the end of the month was over £1 million higher at £35·58 million. Reports from the industry suggest that the recovery has gone further since then, particularly in October and November. There is also encouraging news from other sectors of the capital goods industry: heavy switchgear manufacturers appear to have turned the corner after a depressing 18 months and likewise heavy steel fabrication for the process industries shows a marked improvement.

The danger point remains in the level of exports. Competition has continued to increase during the summer and autumn and there is no sign of a radical improvement in demand. The United States Government's request to the governments of Western Europe and Japan to stop discrimination against dollar products, reflects the urgent desire of the US industry to increase their exports of capital goods, and an all-out drive may be expected over the next few months.

De Havilland Aircraft for US Army

The first YAC-1 Caribou STOL transport aircraft was delivered to the United States army by the de Havilland Aircraft of Canada Limited on 8 October. The capabilities of this aircraft, which has a maximum loaded weight of 26,000 lb are designed for operations from short unprepared fields or hastily improvised battle area landing strips. The take-off and landing distances specified by the designers are within 550 ft and have not in practice exceeded 300 ft. The Caribou is powered by two 1,450 b.h.p. Pratt and Whitney R-2000 engines.

At Home

World Machine

In 1850 Isaac Merritt Singer made his first sewing machine. It would not work. However the trouble was only in the thread adjustment, and when that was put right the machine functioned. This was just as well, for Isaac had borrowed $40 for capital. The success of the machine combined with good salesmanship resulted in an estate which, at his death in 1875 was valued at $13 million.

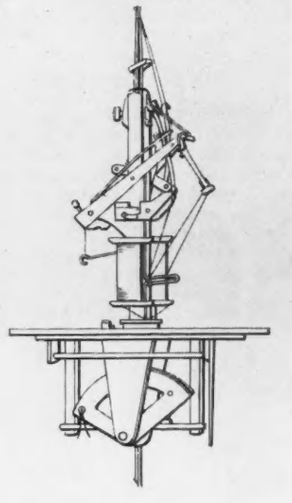
Probably the first practicable machine was that patented by the Englishman, Thomas Saint in 1790. It was intended for stitching shoes and boots, but as far as is known only an experimental one was made and it was fogotten.

Between that time and 1830 attempts were made by a German, Krembs; a Scot, Duncan; an Austrian, Madersperger; an American, Dodge; and a Frenchman, Thimmonier. The last named was the only one to see his machine in production; about 80 were made but he ran into labour troubles and the machines were smashed by the mob who feared loss of work. A second attempt by him in 1848 produced a machine capable of making 200 stitches per minute in materials ranging from muslin to leather, but it met the same fate. By this time the race was on in America, and before Singer produced his first machine no less than a dozen others had entered the field.

Not unnaturally there was some overlapping of patents and at one time there were four manufacturers all suing each other in what the newspapers called the "sewing machine war." The matter was at last ended by a combine—America's first patents pool—since to work well any machine would have to include something from each. It is interesting to note that Singer also seems to have been responsible for another "first," met with everywhere today, namely, hire purchase. As the price of a machine was $125 and the average family income $500 a year, some such arrangement was a necessity.

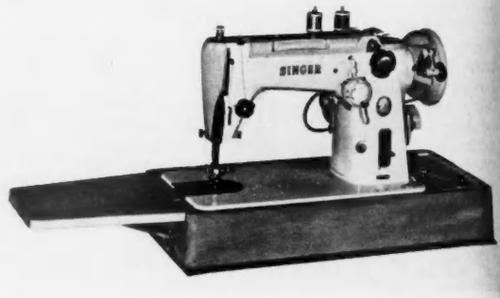
In the 100 years that have passed since Singer first went into production the sewing machine has become the mark of civilisation. There can be few parts of the world where one cannot be found. It seems strange that at one time tailors feared that they would lose their trade to the machine—where is there a tailor now who does not depend on one for getting his work done to time? Sewing machines were one of the very few items that Gandhi exempted from his ban on Western machinery—he said that it was one of the few useful things ever invented. Certainly anyone who has been to the East will have seen the tailor by the roadside, and always with his machine.

There were sewing machines in Africa before Livingstone began his journeyings, and it is still the aim of many a tribesman to own a machine, that he may take it home with him after his schooling is done. Peru and Tibet, the Everglades and Antarctica all have their machinists.



(Left) The machine made by Madersperger received an "Imperial privilege" in 1814.

(Below) The latest Singer machines have attachments that will perform most types of sewing. This one has a swinging needle which enables patterns to be made, while feeding the cloth in a straight line.



For many years the sewing machine changed very little in outward appearance, Even now the major change has been the streamlining of column and arm. The addition of electric power to the hand and treadle operated machines has been one of the main advances. But in the operations that the machine will carry out considerable strides have been made.

The model illustrated, for instance, has what is called a swinging needle and will sew patterns instead of being confined to straight lines. The number of attachments to the foot is legion; there are devices that make and sew a hem of set width—and will sew on lace at the the same time. Others will fix bias binding round an edge with no preparation, and still others will gather the cloth and sew it in ruffles. Some models have adjustment for stitch length enabling anything from 6 to 30 stitches per inch to be made, while some will sew forwards or backwards. In size, machines range from 3 lb in weight to over a ton; the latter is for sewing conveyor belts, though, and is hardly a home model. Really high speed machines running at 5,000 stitches a minute have to have the needles cooled by comdressed air.

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